

EFFECTS OF BIRTH WEIGHT AND
FETAL HEART RATE PATTERNS ON THE
BRAZELTON NEWBORN SCALE

By

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TABLE OF CONTENTS

	<u>Page</u>
ACKNOWLEDGEMENTS.....	ii
LIST OF TABLES.....	v
LIST OF FIGURES.....	vi
ABSTRACT.....	vii
CHAPTERS	
I INTRODUCTION.....	1
II NEWBORN BEHAVIORAL ASSESSMENT.....	7
Brazelton Neonatal Assessment Scale.....	10
Traumatized Newborns.....	11
Low Birth Weight Newborns.....	12
Cultural Differences.....	13
III FETAL HEART RATE MONITORING.....	15
Prediction of Neonatal Condition.....	17
Beat-to-Beat Variability.....	19
Bradycardia, Tachycardia and Decelerations.....	20
Obstetric Medication.....	23
Present Study.....	26
IV METHODS.....	29
Subjects.....	29
Procedure.....	30
Administration of the Brazelton Scale.....	30
Instrumentation for Fetal Heart Rate Monitoring.....	34
Fetal Heart Rate Data Collection.....	34
Fetal Heart Rate Data Reduction.....	35
V RESULTS.....	39
Study I.....	39
Study II.....	43
Study III.....	49

VI	DISCUSSION.....	62
	Methodological Issues in the Use of the Brazelton Scale.....	67
	The Use of Multivariate Statistical Techniques in the Study of Newborns.....	70
VII	CONCLUSIONS.....	72
	Approaches to the Study of Newborn Behavior.....	72
	Single Variable Analysis.....	72
	Dimensional Analysis.....	73
	Implication of Present Findings for Future Research.....	75
	APPENDIX.....	77
	LIST OF REFERENCES.....	78
	BIOGRAPHICAL SKETCH.....	85

LIST OF TABLES

<u>Table</u>		<u>Page</u>
1	Decriptive Characteristics of Pilot Sample.....	40
2	Factor Loadings for Items Defining the Attention-Orientation and Arousal-Temperament Factors on the Brazelton Assessment Scale in Study I.....	42
3	Descriptive Characteristics of the Sample in Study II.....	45
4	Factor Loadings for Defining the Attention-Orientation, Temperament, And Arousal Factors on the Brazelton Newborn Scale.....	46
5	Items from the Brazelton Newborn Scale that Loaded on Factors in Study I and II.....	47
6	Descriptive Characteristics for Sample in Study III.....	50
7	Fetal Heart Rate Factors and Variable Loadings.....	52
8	Multiple Regression Weights of FHR Components and Brazelton Criteria.....	61

LIST OF FIGURES

<u>Figure</u>	<u>Page</u>
I Fetal heart rate showing good variability and minimal changes with contractions.....	53
II Pattern with high baseline rate, low variability and uniform decelerations with contractions.....	55
III Pattern with accelerations extending over two minute period.....	56
IV Baseline rate maintained around 120 bpm with sinisoidal characteristics.....	57
V Pattern showing diminished baseline rate and uniform decelerations.....	58
VI Diminished baseline rate and biphasic heart rate changes with contractions.....	59

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The Brazelton Neonatal Assessment Scale was administered to 52 newborns who were divided into Low Birth Weight (LBW) and Full Birth Weight (FBW) groups. A factor analysis (varimax rotation) of the Brazelton Scale found two main factors along dimensions of attention-orientation and temperament-arousal. The factors accounted for 38% of the variance. Multiple regression analysis found birth weight was the best high-risk predictor of the attention-orientation factor.

Ninety-two additional newborns were administered the Brazelton Scale bringing the total number to 144. A high birth weight group (HBW) was included in the sample. A second factor analysis (varimax rotation) on the total sample found three main factors along dimensions of attention-orientation, temperament, and arousal. A 2(sex) by 3(birth weight) factorial design with gestational age covaried found a significant main effect for birth weight on the attention-orientation factor. FBW newborns scored higher than LBW and HBW subjects. A significant sex by birth weight interaction was found for the temperament and arousal factors.

In the third study Fetal Heart Rate (FHR) tracings for 120 of the 144 subjects were obtained. A quantitative system for scoring FHR patterns which resulted in 18 variables was devised. A factor analysis (varimax rotation) of the FHR patterns found six factors. Step-wise multiple regression analysis found that FHR factors significantly predicted the attention-orientation and arousal factors. Analysis of variance found no significant effect for birth weight on the FHR factors. Canonical correlation analysis of the FHR factors and the Brazelton attention-orientation and arousal factor items was not significant. Results are discussed in terms of methodological issues and implications for high-risk and life-span developmental research.

CHAPTER ONE INTRODUCTION

In the past century great strides have been made in reducing the risk once associated with early growth and development. Sameroff and Chandler (1975) have asserted that children born in this decade are more likely to survive and grow to healthy maturity than were children born only a generation ago. The last half decade had hosted a wide variety of books, collections of readings, and chapters devoted solely to the infant, a sure sign that there is indeed a field to talk about. Haith & Campos (1977) feel that the chapter devoted to infancy in the 1977 Annual Review of Psychology probably could not have been written 10 or even 5 years ago. Although the 1970 chapter on infancy in Mussen's revision cited over 2000 references, it is unlike the recent appearance of large programmatic reports that have appeared since the pre-1970's (Haith & Campos 1977). Therefore, in the pursuit of knowledge about the causal and interrelated factors which adversely affect child development, the need for scientific rigor and methodological sophistication should not be compromised. This will help insure that conditions associated with neonatal mortality and morbidity can be identified.

Of all known complications of pregnancy and parturition no single condition is more clearly associated with a wide range of insults to the nervous system than low birth weight (Birch & Gussow 1970). The single most prevalent abnormality associated with natality is low birth weight. The death rate alone of the low birth weight neonate is forty

times that of the full sized infant born at term (NCHS, 1965). Additionally, the oversized or large for gestational age infant is also at increased risk of mortality (Vaughan & McKay 1975). Those low birth weight infants who do survive are at increased risk for the development of neurological, mental, or sensory deficits. There is a list of documented abnormalities and problems associated with low birth weight which is extensive. Included among these abnormalities are impaired mental development, mental retardation, cerebral palsy, epilepsy, autism, blindness, hyperkinesis, abnormal EEG activity, deficits in physical growth, and greater risk of infectious disease (Birch & Gussow 1970; Caputo & Mandell 1970).

The consequences of high birth weight, in particular the behavioral sequelae associated with it, are virtually unknown. This lack of knowledge leads to some speculation as to whether birth weight represents a normal continuum of development from unhealthy to healthy. This notion may be untenable since it is known that there is a group of premature infants in the 20 week gestation range that are above the 75th percentile in birth weight who usually die in utero (Vaughan & McKay 1975).

Birth weight is a powerful predictor variable from an epidemiological point of view. It allows one to draw a reasonably accurate picture of the distribution of reproductive anomalies. Put more succinctly, populations which experience a higher than average rate of infants with extreme birth weights will have children who are exposed to higher than average risk for damage. Lubchenco (1976) has pointed out that birth weight alone has been used very successfully as an indicator to identify infants at risk of neonatal morbidity. The category of low birth weight

infants--that is, infants with birth weights less than 2500 grams--remains a useful division for investigating problems and assigning care. However, neonatal mortality statistics show that infants weighing over 2500 grams constitute one third of the high risk population in most nurseries (Lubchenco 1976).

Since birth weight is affected by gestational age the use of this parameter in conjunction with birth weight adds another dimension that must be considered in arriving at an understanding of newborns. Birth weight in relation to gestational age adds information in excess of other factors operating during perinatal life. What seems important is that gestational age provides an automatic correction factor for birth weight.

While birth weight in relation to gestational age provides an excellent parameter for grossly categorizing newborns, it is suspected that other variables act interdependently and may result in a newborn of small, average, or large proportions. Unfortunately the very interrelationships with other complications of the reproductive process which make birth weight a representative entity also make it extremely difficult to assess its importance as a cause of damage.

In recent years increasing attention has been directed towards the study and early identification of various factors which place children at a greater than average risk for later disease or disorder (Sameroff & Chandler 1975). It has already been mentioned that birth weight alone represents a significant high risk variable. The escalation of interest

in risk research is also related to another principal factor. It is the growing disenchantment with retrospective or "followback" studies as a means of increasing our understanding of the etiology of various disorders. As a result of such concerns there has been a shift in emphasis toward prospective, follow-up studies, the conduct of which typically involves the early identification and longitudinal study of high-risk populations (Garmezy 1972).

In order to give some appreciation of the need for high risk research one need only review the report by Babson and Benson (1971). Of the 5-10 million conceptions occurring annually in the United States, 2-3 million result in spontaneous abortions due to genetic or chromosomal defects and pathogens, and another one million are terminated legally or illegally. Of the approximately 3.5 million fetuses that reach twenty weeks of gestational age, 50,000 die before delivery, 50,000 die in the first postnatal month, 50,000 have severe congenital malformations, while another 300,000 have learning disorders that range from mild to severe retardation.

The lack of either a clear cut anatomical or genetic basis in many children with sensory and behavioral disorders presented adherents of the "medical model" with a difficult problem. According to this model a clear etiologic factor, presumably biological, should be present somewhere in the patient's history. While this approach is reasonable and often helpful, it leaves much unexplained. There are at least two main reasons why the "medical model" approach to this area has resulted in less than optimal results. First, many of the diagnostic techniques detect symptoms which

are manifestations of structural and metabolic dysfunction. Second, many developmental anomalies are associated with socio-cultural variables and are not easily identifiable on the basis of biological diagnostic techniques. The relationship among these variables fit very well into the conceptualization of a continuum of reproductive risk and caretaking casualty. This conceptualization includes the original term of "reproductive wastage" (Lilienfeld & Parkhurst 1951) and later expanded to include "continuum of reproductive casualty" (Pasamanick & Knobloch 1961). The final modification of the term adopted by Sameroff & Chandler (1975) regards both the reproductive and caretaking histories of the child as important; hence the term "reproductive risk and the continuum of caretaking casualty." These authors feel that many more predictions about developmental outcome are possible when both sets of variables are taken into account.

What Sameroff & Chandler (1975) imply is the following: first, there is a need for more sophisticated assessment measures of the newborn and also representative behavioral measures as well. Second, an assessment of the psychological make-up of the principal caretaker must also be established. Third, there is a need for an indepth analysis of the caretaking environment and the type of requirements it makes upon the child. Fourth, one should attempt a transactional analysis of the interface between the proprioceptive and exteroceptive stimuli which constitute the child's environment.

It should be clear that the preceeding recommendations would entail a large scale and comprehensive research program. However, the limitations

in funding and commitment would necessitate a clear vision and focus on the part of researchers in the infancy field. These conditions would also require the selection of appropriate and sensitive measures which would have some degree of theoretical impact, empirical verification, and clinical usefulness.

The logical and scientific approach to this problem requires that one proceed from what is empirically known and validated. In the case of newborn research, one consistently notes an increased incidence of sensory, behavioral, and mental disorders in various high risk populations. It has already been stated that the most prevalent abnormality associated with natality is low birth weight (Caputo and Mandell 1970).

The focus of the present investigation is based on the assumption that birth weight as a categorical variable is useful. Its usefulness is limited, however, because it represents the outcome of various other variables which act upon the fetus during gestation. However, physiological and behavioral correlates may help to improve our understanding of the newborn. It may be possible to distinguish the marginally functional infant from the one who is simply small or large for its gestational age. With this orientation the present investigation is undertaken. An attempt will be made to analyze the relationship between newborn behavior and fetal heart rate patterns during labor. The sample will be comprised of subjects representing a spectrum of birthweights found in newborns of essentially term gestations.

CHAPTER TWO NEWBORN BEHAVIORAL ASSESSMENT

It has been pointed out by Self (1971) that the behavioral assessment of the human newborn infant has developed along three basic lines. The older and more well known of these procedures is specifically designed to evaluate levels of neurological development in the neonate. The assessment procedures of Andre-Thomas, Chesni & Saint-Anne Dargassies (1960) and Prectl & Beintema (1964) are characteristic of this group. These procedures typically involve eliciting a variety of reflexes. Included among these are the Moro, Babinski, Tonic-neck-reflex, and other postural reflexes. Levels of central nervous maturity are inferred from the vigor and latency of these reflexes.

A second line of assessment procedures known as developmental screening devices are currently in widespread use. Included in this category are instruments such as the Apgar and Denver Developmental Screening Test. The Apgar provides an immediate evaluation of newborn physiologic function after birth. The Denver has a higher basal level and extends through the pre-school years. Despite a heavy emphasis upon social competence at the higher levels of the scale, several items have implications for neurologic and neuropsychologic development.

Assessment procedures which are broadly classed as "behavioral assessments" define a third dimension of infant testing. They can be distinguished from neurological assessments and screening devices because their emphasis is upon broader representation of behavioral response

systems. Commonly used tests in this category include the Bayley Scales of Infant Development and the Gesell Developmental Schedule. For the most part the procedures found in these two latter groups of assessment instruments are standardized on infants at least four weeks old. The Brazelton Neonatal Assessment Scale is an exception and is designed specifically for use with neonates. A more thorough discussion of the Brazelton Scale will follow a brief discussion of the theoretical orientation which seems to characterize current newborn behavioral research.

It has been said that one line of neonatal behavioral assessment relies heavily upon reflexive responses. These procedures predate other behavioral assessments in current use which increasingly rely upon interacting systems and organizational capacities. However, Uzgiris (1973) has argued that a disproportionate amount of infant research continues to focus upon specific behaviors. Such an atomistic approach can potentially retard the study of interrelationships among infant response systems. The study of these relationships can provide a congruent picture of the infant as an integrating and functional organism. This notion has received some attention in the literature (Bell, Weller & Waldrop 1971; Kessen 1967). Nash (1970) suggests that research be geared towards the interaction of more than one sensory system. Luria (1973, p. 32) citing Vygotsky's earlier work suggests that it is not only the structure of mental processes that change but also their relationship with each other. In other words, their interfunctional organization is altered by the process of maturation and experience. Luria also states

that whereas in the first stages of development a complex mental activity rest on a more elementary basis and depends on a "basal function", in subsequent stages of development it not only acquires a more complex structure, but also starts to be performed with the close participation of structurally higher forms of activity (Luria 1973, p. 32). These processes parallel and mirror the development of behavioral response systems. They also have implications for understanding the evolution of infant behavioral assessment. Thus, while it may be hazardous to speculate, researchers in the field of infancy seem to recognize the limitations of paradigms which adhere to strictly cause-effect models. It is appropriate to suggest that neither neural nor behavioral development can be fully understood and appreciated until the interrelatedness of function within and across systems is taken into account.

One can view the developments in newborn behavioral assessment as reflecting the spirit of the times. The behavioral assessment of the newborn now seems to convey the realization that many systems are functional and operating soon after birth. The emphasis on "organized behaviors" and modulation of state reveal an increased awareness that behavioral competence results more from cross-modal and integrative capacities than from isolated response capabilities.

A trend has been detected in newborn research. Its development appears to be related to our understanding of the evolution of the central nervous system and a hierarchical arrangement of cognitive processes (Luria 1973; Isaccson 1974). The incorporation of these perspectives into newborn research provide a level of interpretation

relating genotypic development to phenotypic expression that had not been achieved. The early focus upon reflexive behaviors in infant assessment reflected our interest in more primitive and "basal" CNS functioning. Contemporary procedures allow for a higher level of phenotypic expression characteristic of the neonatal period. Thus, just as ontogeny recapitulates phylogeny in fetal development, the status of newborn behavioral assessment appears to recapitulate our experience with infant testing. The Brazelton Neonatal Assessment Scale seems to fit into the framework of newborn assessment that has just been proposed. The following section will review some of the studies that have been reported using the scale.

Brazelton Neonatal Assessment Scale

Several recent behavioral studies of the human neonate have used the Brazelton Neonatal Assessment Scale. The scale has been used in a variety of behavioral settings and represents an integration of many earlier behavioral assessment scales, in particular the Cambridge Newborn Scale (Brazelton & Freedman 1971). Brazelton (1973) states that the scale is designed to score interactive behavior and that the main thrust of the evaluation is behavioral. One particular aspect of the scale that departs from other standardized assessment procedures is its emphasis on obtaining optimal performance from neonates. The examiner should attempt in all instances to elicit from the infant the best responses that can be obtained. The Brazelton Scale appears to be sensitive to several dimensions of neonatal behavior. These include reflexive, temperamental, and attentional. When behaviors reflecting these dimensions are elicited or observed during the assessment of the

neonate the advantages of the scale become apparent. They include, in addition to the scale's overall sensitivity, emphasis upon optimal performance, a primarily behavioral thrust, and the assessment of responses in various states of arousal (Emory, Lester, & Eitzman 1976). The behavioral breadth of the scale makes it application for the assessment of clinically abnormal newborns as well as with infants from a variety of cultural and racial backgrounds. The neonates performance is assessed and scored on the basis of 27 behavioral items in addition to several reflexes. The Brazelton is considered to be a psychological scale for the neonate. It allows for the evaluation of the infant's capabilities along dimensions which are related to the general behavioral repertoire of the newborn. Inter-rater reliability for the items that make up the scale have ranged from .85 to 1.00 (Brazelton 1969; Freedman & Freedman 1969; Horowitz 1971; Lester, Emory, Hoffman, & Eitzman 1976). Horowitz (1971) has reported retest reliability from three days to one month of .59 for males and .65 for females. A follow-up study also found the scale to be predictive of developmental status at age seven compared with a standard neurological examination. A much lower proportion of false positives was found with the Brazelton (Tronick & Brazelton 1975).

Traumatized Newborns

The claim that the Brazelton is applicable across varying infant populations is illustrated in a number of recent studies. Studies of traumatized newborns born to narcotic addicted mothers have shown the scale to be sensitive to the state of narcotic withdrawal in the newborn. Soule, Standley, Capans, & Davis (1974) found that infants experiencing

narcotic withdrawal as a result of their mother's methadone treatment were more neurologically irritable when compared with controls. Strauss, Lessen-Firestone, Starr, & Ostrea (1975) found that addicted infants were less able to maintain alert states and less able to orient to auditory and visual stimuli than control infants.

Low Birth Weight Newborns

The Brazelton scale has also discriminated infants on the basis of birth weight. In a study by Scarr & Williams (1971) it was found that low birth weight infants have lower scores on a variety of items relating to attention and arousal than did full sized infants. Of the two factors generated by a factor analysis, the first suggested a dimension of behavioral and neurological maturity while the second seemed to tap a reactive pattern. In a multivariate statistical study of the interdependence of high risk factors on newborn behavior Lester, Emory, Hoffman, & Eitzman (1976) found that birth weight was the best single predictor of items representing an attention-orientation factor on the Brazelton scale. These results are consistent with those of Scarr & Williams (1971) but also show the interdependence of other high risk variables on newborn behavior. While empirical evidence, as mentioned in the introduction, is fairly consistent with respect to findings related to low birth weight and prematurity (Birch & Gussow 1970; Weiner, Bider, Oppel, & Harper 1968; Caputo & Mandell 1970), one must exercise caution in the interpretation of these results. The implication of a positive correlation between birth weight and newborn behavior may be suspect. To infer an underlying defect based upon low birth weight could lead to erroneous conclusions about the relative importance of other variables. In this

light the study by Lester et al. (1976) has special significance as it attempted to take into account the relative contribution of other variables in addition to birth weight. Their approach was to assess the combined effects of various factors upon neonatal behavior.

Cultural Differences

Differences among infants from various racial and cultural groups have also been reported using the Brazelton scale. Freedman & Freedman (1969) found behavioral differences between Chinese-American and European-American born newborns. Caucasian newborns showed greater lability of state, slower habituation and less self-quieting than the Oriental infants. Temperamental differences were also reported by Brazelton & Collier (1969) in which they found greater motor maturity, smoother transitions from state to state, and an ability to maintain sustained periods of alertness in Zinacanteco Indian newborns as compared to American newborns. Recently Brazelton, Koslowski, & Tronick (1976) reported behavioral differences between American and Zambian newborns at 1, 5, and 10 days after birth. Zambian newborns scored lower on items that reflect reactivity at one day. By day 10 the Zambians were scoring higher on items that measured social attentiveness.

Although the volume of published literature and research is currently small, the excitement the Brazelton scale has generated regarding its potential usefulness is quite strong. In keeping with a trend in research where the focus is on organized behavior and the general integrative capacities of the neonate, the Brazelton Neonatal Scale may prove helpful in a number of areas which have received limited attention. The literature cited here describe some uses of the scale and its

discriminative sensitivity to a number of factors which exert an influence upon newborn responsiveness.

CHAPTER THREE FETAL HEART RATE MONITORING

The history of fetal monitoring as compared with other medical accomplishments of past centuries is still very young. However, many of the important insights that have now been substantiated by continuous fetal monitoring had been gained much earlier than some current investigators recognize (Zootzmann 1975). One need only note that as early as 1858 detection of decelerations of the fetal heart frequency which extended into the interval between contractions was a serious risk factor for the fetus. In fact, the importance of obstetric auscultation was realized even earlier in a paper by Kergaradec which was read to the Academie royale de medicine in Paris in December, 1821. After 1850 several papers began to appear which investigated specific topics such as heart rate changes to contractions, fetal movements, and maternal heart rate and temperature (Zootzmann 1975). Subsequent methods for more detailed examination of cardiac action such as amplification of heart tones, graphic recordings, and fetal electrocardiogram were developed after 1930.

It is now well recognized that labor is a stress to the human fetus which is well tolerated in most instances (Freeman 1974). However, when uteroplacental respiratory function is impaired or there is umbilical cord compression the fetal reserve may be exceeded. Circumstances such as these often result in asphyxia neonatorum, permanent neurological damage, or intrapartum fetal death (Freeman 1974). Based on the premise that careful assessment of fetal heart rate patterns

during labor will indicate the presence of fetal distress or compromise, continuous fetal heart rate monitoring has become a current practice in perinatal units (Low, Pancham, Worthington 1977).

The popularity of intrapartum monitoring is based on the assumption that perinatal mortality and morbidity rates will be lowered (Quilligan & Paul 1975; Saling & Schneider 1967). Few studies have been published which support this premise. However, there is sufficient indirect evidence suggesting that proof will be obtained to substantiate the principle (Cililis 1975).

Methods for monitoring fetal heart rate and uterine contractions are currently used in many centers to assess fetal welfare and the progress of labor accurately (Chan, Paul, & Towes 1973; Paul & Hon 1971). In recent years however, the search for a means of improving the physical and mental health of children has led inevitably to a more critical assessment of the influence of the intrauterine environment, particularly with regard to intrapartum asphyxia (Beard 1974). The principle underlying the detection of fetal asphyxia by continuous fetal heart rate (FHR) monitoring is that uterine contractions serve as intermittent stressful stimuli to the fetus. With each contraction there is a temporary reduction in the flow of oxygenated blood through the intervillous space. If placental function is impaired before the onset of labor or if contractions are too frequent then the fetus is liable to become asphyxiated. Because auscultation is confined to the interval between contractions, the detection of fetal asphyxia is likely to be delayed longer than if continuous recording of the FHR is used.

Due to these circumstances it is important to recognize that perinatal mortality is no longer accepted as the most important yardstick of clinical excellence. Prevention of asphyxial damage among survivors is of even greater concern than salvage. This line of reasoning is extended to include those instances where clear evidence of asphyxial damage can not be accurately determined but there is an indication of fetal vulnerability or compromise. Continuous monitoring of the fetal heart rate during labor can provide this early warning system. Otherwise these sub-lethal and low-amplitude conditions may remain undetected until formal demands requiring higher levels of integrated central nervous system functioning are necessary.

Prediction of Neonatal Condition

Several investigators have made efforts to predict the condition of the human neonate from the fetal heart rate patterns obtained during labor. Freeman (1974) points out that there is a very unstable correlation between fetal heart rate patterns (e.g., late decelerations, severe variable decelerations) and 5-minute Apgar scores. A report on a series of one-thousand monitored labor patients found that four times as many patients who manifested late decelerations anytime during labor had babies with Apgar scores below 6 at one minute when compared with those patients who had no periodic changes in fetal heart rate (Shenker 1973). However, sixty-eight percent of the babies whose records showed late decelerations were born without signs of depression as indicated by Apgar scores above seven. Schifrin & Dame (1972) have found that non-ominous fetal heart rate patterns (e.g., periodic changes, accelerations,

early decelerations, or mild variable decelerations) correlated with 5-minute Apgar scores above 7 over 99 percent of the time if other intrapartum events were controlled. Contradictory findings were reported by Saldan, Schulman, & Yang 1975. A three times greater occurrence of late decelerations in patients having 1-minute Apgar scores of 6 or less was observed. A recent study by Chik, Sokol, & Rosen (1976) used fetal heart rate patterns to predict Apgar scores using a multivariate statistical technique. Discriminant function analysis was performed using the number of late decelerations and uterine contractions as observation vectors. Forty-seven percent of the low Apgar infants and 57 percent of the high Apgar infants were appropriately identified for an overall hit rate of 54 percent. When early decelerations and accelerations were added to the analysis 67 percent of the low Apgar infants were correctly identified. This study also suggested that multivariate procedures applied to fetal heart rate data may have predictive utility.

Studies investigating specific components of the fetal heart rate patterns (e.g., accelerations and decelerations) have attempted to study their relationship to hypoxia and other clinical conditions. Although these studies are less numerous than other investigations of fetal heart rate patterns in general, there is some agreement as to their significance. In a study of fetal heart rate acceleration patterns it was found that accelerations are the most frequent heart rate change found and are thought to reflect fetal well being (Lee, Di Loreto, & O'Lane 1975; Rochard, Schiffrin, Goupil, Legrand, Bottiere, & Sureau

1976). Hon (1975) states that variable accelerations are associated with fetal movements and are considered to be an indicator of well-being. Hon also notes that uniform accelerations are probably an early indicator of fetal distress that may become associated with late decelerations. It is not clear whether Lee et al. made this distinction in their study of accelerations patterns. The major clinical finding, however, has been that accelerations alone have not been associated with poor clinical outcome.

Beat-to-Beat Variability

Beat-to-beat variability or baseline variability distinguishes another aspect of the fetal heart rate pattern that is associated with neonatal outcome. Rochard et al. (1976) found bradycardia and tachycardia were unreliable signs of fetal distress antepartum. Of 12 fetuses in this study who dies during observations, 6 showed late decelerations with spontaneous uterine contractions but all showed diminished baseline variability. Cibils (1975, 1976) reported that small fetuses who showed poor neonatal outcome had a high incidence of tachycardia and a fixed baseline. Fixed baseline was defined as a lack of "rapid oscillations" of the baseline which generally occur at a frequency of 3 to 6 beats per minute with a range of up to 15 beats per minute. It was noted that the fixed baseline pattern seems characteristic of prolonged gestation and placental insufficiency.

The explanation for the mechanism controlling beat-to-beat variability holds that with advancing gestation fetal heart rate decreases

and variability increases. This probably represents an increasing influence of the fetal central nervous system, especially the vagus, on heart rate (Schifferli & Caldeyro-Barcia 1973; Rochard et al. 1976). The loss of beat-to-beat variability suggests a blunting of homeostatic mechanisms involved in controlling fetal heart rate. There is also an increased likelihood of late decelerations during spontaneous contractions in fetuses who show a loss of beat-to-beat variability (Rochard et al. 1976).

Bradycardia, Tachycardia and Decelerations

It has been known for some time that bradycardia and tachycardia, which describe baseline fetal heart rates below 120 and above 160 beats per minute respectively, are clinical indicators of a non-optimal fetal condition. However, the characteristic of fetal heart rate patterns that has received the most systematic investigation is decelerations. The reason for the focus upon decelerations relates to the consistently poor neonatal outcome of fetuses who show decelerations. The relationship between decelerations and Apgar scores have frequently been reported (Martin, Siassi, & Hon 1974; Freeman 1974; Schiffrin & Dame 1972; Shenker 1973; Saldan et al. 1976; Chik et al. 1976). Other studies have investigated the relationship between decelerations and asphyxia (Low et al. 1977; Low, Pancham, Worthington 1975; Tejani, Mann, & Bhakthavathsalan 1976). Still others (Cibils 1975; 1976; Rochard et al. 1976) have studied the relative clinical significance of fetal heart rate patterns during labor and the role of non-stressed fetal heart rate monitoring. Lastly,

an experimental model in the sub-human primate for direct monitoring during labor has been developed (James, Morishima, Daniel, Bowe, Cohen, & Nieman 1972).

The general consensus of the humans studies is that fetal heart rate decelerations, particularly late decelerations, in conjunction with uterine contractions constitute one of the most clinically significant and ominous signs of fetal compromise that can be determined from this procedure. To be sure there are other patterns, such as the sinusoidal pattern (Basket & Koh 1974; Rochard et al. 1976), which show a high incidence of Rh incompatibility and fetal death. However, this pattern is much less frequently observed than the patterns of decelerations. In a study of fetal heart rate patterns in relations to asphyxia and weight-gestational age percentile of the fetus, Low et al. (1976) found that there was a significant relationship between the number of total and late decelerations and fetal asphyxia. These authors also report significant relationships between decreasing weight-gestational age of the fetus and increasing frequency of total and late decelerations. Moreover, the weight-gestational age percentile is considered yet another variable which will influence fetal heart rate patterns. Tejani et al. (1976) used deceleration patterns in conjunction with fetal pH. Where pH was less than 7.2 neonatal depression occurred in 88 percent of the cases. However, Low et al. (1976) suggest that mechanisms other than fetal asphyxia will cause fetal heart rate decelerations and that fetal asphyxia may in some instances develop in the absence of total or late decelerations. These researchers point out that an increasing incidence of total and late decelerations are of value in the prediction of fetal

asphyxia. In other studies (Cibils 1975) found that there is an extremely low likelihood of neonatal problems (0.5 percent) when there are no decelerations of the fetal heart rate. Conversely, Rochard et al. (1976) reported that of 12 fetuses who died during observations six showed decelerations with spontaneous uterine contractions.

Empirical evidence relating decelerations to variables such as fetal distress and asphyxia have created an interest in the biologic mechanism responsible for them. The literature still reflects some uncertainty as to the specific mechanism or process responsible for fetal heart rate decelerations (Low et al. 1977). The relationship between fetal heart rate and asphyxia offers grounds for speculation albeit inferential. James et al. (1972) used rhesus monkeys, java monkeys, and baboons and found that in those fetuses who became acidotic, hypoxic, and hypotensive as labor advanced, there was an increase in baseline heart rate and late decelerations following uterine contractions. It was also reported that late decelerations were abolished or suppressed when the level of fetal oxygen was increased. Moreover, since fetal acidosis and hypotension remained, it was concluded that fetal hypoxia is the essential element producing late decelerations of the fetal heart rate. Human studies (Mendez, Arnt, Girdlin, Escarent & Caldeyro-Barcia 1967) suggest that decelerations have two components; one is a vagal reflex and the other seems to be a direct effect of hypoxia upon the myocardium.

As has been pointed out, much of the interest in fetal heart rate is related to the clinical significance of the patterns. Fetal heart

rate monitoring provides an on-going assessment of the fetus as labor progresses and may help determine the status of fetuses who may have marginal reserves. However, there remain those fetuses who show patterns of an ominous nature but their clinical condition is satisfactory. It is important therefore, to distinguish these "false positives" from those fetuses who are truly compromised. What are the other factors which produce fetal heart rate patterns that mimic those observed in compromised infants. Currently under debate is the possible effects of obstetric medication given to the mother during labor and its effect upon the fetal condition. The next section will discuss the effects of obstetric medications given to the mother during labor and its effect upon fetal heart rate and neonatal behavior.

Obstetric Medication

Drugs administered to the mother during delivery that are transferred to the fetus often result in neonatal depression. The distribution of the drug is contingent upon its chemical composition, the mother's ability to metabolize and excrete the drug, the rate of diffusion through the placenta, and the dynamics of fetal circulation and metabolism. Drug transfer to the fetus may be through the placenta or, if the drug is concentrated in the amniotic fluid, it may be ingested by the fetus in higher dosage than is suspected from maternal plasma levels. Studies investigating the effects of obstetric medication upon fetal heart rate patterns is somewhat inconclusive. Intuitively one would expect to observe some effect upon the fetus from analgesic and anesthetic agents. Vasicka, Robertazzi, Raji, Scheff, Kosmowski, &

Goei (1971) found that there was a slight change in fetal blood pH and transient decelerations of the fetal heart rate following paracervical block. Under balanced anesthesia Timor-Tritsch, Gergely, Abramovici, & Brandes (1976) found that there was significant decrease in beat-to-beat variability of the fetal heart rate most probably due to anesthesia. Lumbar epidural anesthesia has also been shown to affect baseline variability (Boehm, Woodruff, & Growdon 1975). Beard (1974) has suggested that loss of beat-to-beat variability or "smoothing" of the fetal heart rate is also a sign of fetal asphyxia but it is known that sedatives and analgesics administered to the mother during labor can produce a trace almost indistinguishable from one due to asphyxia. Thus, as Boehm et al. (1975) state, "such changes in fetal heart rate does not in itself seem indicative of fetal distress but suggest supportive measures for the patient." A study which demonstrated a different effect upon the fetal heart rate was reported by McDevitt, Wallace, Roberts, & Whitfield (1975). Intravenous salbutamol, a B-adrenoceptor stimulant, had the effect of increasing both maternal and fetal heart rates. When plactolol, a B-adrenoceptor blocking agent, was administered it reduced the maternal heart rate, but not that of the fetuses. This finding has significance for distinguishing the differential responses of maternal and fetal autonomic systems to obstetric drugs. Ballas, Toaff, & Toaff (1976) studies the effects of intravenous meperidine and meperidine with promethazine on uterine activity and fetal heart rate. They found no significant changes in uterine tone and no adverse effect of the fetal heart rate. Similarly, Goddard (1971) reports that following

paracervical block anesthesia only one third of his sample showed a drop in fetal heart rate down to the bradycardia range. In over one third of the subjects there was no drop in the fetal heart rate. Because of these contradictory findings, Brown, Bell, & Alper (1976) consider whether the cause of neonatal depression is asphyxia and acidosis, the high concentrations of anesthetic agents, or both. Thus, the effect of obstetric medication on the fetus and newborn remain open to question. Some of the disparity of findings can be linked to the use of different drugs, dosage levels, administration and measurement times, inconsistent results can be expected. The point is illustrated by Aleksandrowicz (1973) who states that babies of mothers who were given medication during the last hour before delivery are not necessarily free from the effects of the drug but the peak effect has yet to be reached. Brazelton (1970) noted; "...Some neonates had excellent Apgar scores in the delivery room and remained clinically responsive for half an hour---long enough to be sent to the nursery. After this initial period of responsiveness, these babies shifted rapidly into a frightening state of relative unresponsiveness and became unresponsive to any but very disturbing stimuli." These observations reveal that the effects of obstetric medication are not limited to the fetal heart rate alone but may also exert influences upon neonatal behavior. This point has received considerable attention in the literature (Aleksandrowicz 1973; Conway & Brackbill 1970; Aleksandrowicz & Aleksandrowicz 1974; Bowes, Brackbill, Conway, & Steinschneider 1970; Gabert & Stnechever 1973).

Obstetric medication has been related to neonatal visual attentiveness and neonatal habituation (Stechler 1964; Moreau & Birch 1974). Motor performance of neonates has been related the amount of sedatives the mother received (Conway & Brackbill 1970). Brackbill, Krane, Maniello, & Abramson (1974) found a direct relationship between the amount of drugs excreted by the neonate after delivery and its performance on a standard developmental test. In other studies the Brazelton scale is found to be sensitive to the effects of obstetric medication on newborn behavior. Standley, Soule, Copans, & Duchowney (1974) found that in three day old newborns anesthesia had a greater influence on behavior than did analgesia. When the effects of analgesia were controlled, infants of mothers who received anesthesia showed increased irritability and decreased motor maturity compared to those without anesthesia. Aleksandrowicz & Aleksandrowicz (1974) also found effects of obstetric medication on some selected Brazelton items chosen to represent the dimensional characteristics of the scale. In contrast to these findings Bell, Weller, & Waldrop (1971) were unable to find a relationship between drug amounts the mother had received during labor and the behavior of the newborn. Yang, Zweig, Douthitt, & Dederman (1976) reported unimpressive results using multiple regression analysis to predict neonatal outcome from pregnancy, drug, and labor variables. It seems the data are also inconclusive as to the relationship between obstetric medication and behavioral measures of newborn functioning.

Present Study

The studies reviewed thus far relate to some of the issues in newborn research. One can also gain some appreciation of the difficulty inherent

in controlling and detecting the interrelationships among perinatal variables and neonatal outcome. For the most part studies using fetal heart rate patterns during labor, as a predictor variable, have relied upon the Apgar score as a measure of neonatal behavior. The Apgar score, as a measure of neonatal functioning, does have empirical support. However, it is a somewhat gross instrument and may be a better indicator of cardiovascular and physiologic functioning. It is considered a poor predictor of neonatal outcome and also correlates poorly with subsequent behavior (Beard 1974; Martin, Siassi, & Hon 1974).

The relationship between fetal heart rate patterns during labor and performance on the Brazelton Neonatal Assessment Scale has not appeared in the research literature. Given that both of these measures are multivariate in nature and represent various aspects of neonatal functioning, an investigation of their relationship is both intriguing and warranted. Several studies with the Brazelton scale have found it useful for identifying some behavioral dimensions e.g., attention, temperament, arousal. A bias which remains concerns the extent Brazelton Scale differences are confounded by the effect of other variables. Soule et al. (1974) argued that several variables act interdependently produce variations in Brazelton Scale performance. The study by Lester et al. (1976) is a case in point. Also, multivariate statistical procedures have not been applied to fetal heart rate patterns in an effort to delineate underlying dimensions that may exist. Chik et al. (1976) used the absolute number of late decelerations and uterine contractions as observation vectors in a discriminate function analysis. There was no attempt made to examine other dimensions of fetal heart rate

patterns which may be of value. Moreover, fetal heart rate patterns consist of several dimensions of base rate, frequency, and magnitude. Much of this information is lost or obscured using univariate analysis.

The present study takes these considerations in mind. The categorical variable of birth weight discussed in the introduction provides a background where a full dimension of newborn status can be portrayed. The methodological difficulty of obtaining such a sample is overshadowed by empirical questions that are addressed in addition to theoretical implications.

CHAPTER FOUR METHODS

Subjects

This investigation will report the results for a series of three studies on a total sample of 144 newborns. All of the subjects were born at the Shands Teaching Hospital of the University of Florida. The data were collected during the period extending from November 1975 through August 1976. The sample was drawn from the North Central Florida catchment area which comprises a predominantly high risk population. At the time of testing, seventy-one percent of the subjects were enrolled in the Maternal Infant Care Program (MIC). Many of the other subjects were later assigned to MIC status following their admission to the hospital or prior to their discharge. The MIC population consist primarily of low socioeconomic status Black families. All of the subjects were clinically normal newborns between 18 hours and five days of age at the time of testing. Clinically normal for this subject pool is defined as the absence of major birth complications which indicate the need for intensive care. All of the subjects were obtained from the well baby nursery. Subjects were born to mothers who had had basically uneventful pregnancies. Cesarean sections comprised 14.3 percent of the sample.

The total sample consisted of 73 males and 71 females. Subjects were divided into three birth weight groups. The low birth weight group contained 15 males and 24 females between 1000 and 2500 grams.

The full or average birth weight group contained 41 males and 37 females and ranged in birth weight from 2501 to 3900 grams. The high birth weight group ranged from 3901 to 5500 grams and contained 17 males and 10 females. The distribution of social class and obstetric histories were similar in the three groups. There were 20 percent more white newborns in the high birth weight group than in the other two groups.

Procedure

Each subject was observed in the newborn nursery for a period not exceeding three minutes and approximately midway between two feedings. The decision for inclusion in the study was based upon the newborn's state during the observation period. Subjects who were judged to be in a sleep state, as agreed upon by two observers, were included if they satisfied all other criteria. Sleep states were determined using Brazelton's classification (Brazelton 1973). Other criteria for the study included a gestational age greater than 37 weeks, and the absence of major birth complications. This criteria was flexible for some of the very small infants who were less than 37 weeks in gestational age but were known to be below the 10th percentile for age and weight. Subjects more than three weeks below our criterion for gestational age were not included regardless of their birth weight. Additional criteria were the mothers participation in or eligibility for the Maternal Infant Care (MIC) program.

Administration of the Brazelton Scale

The administration of the Brazelton Scale was conducted according

to standard procedures described by Brazelton (1973). However, the variation in facilities from one setting to another make detailed description of our procedure helpful.

A dimly lighted room located approximately 75 feet from the nursery served as our testing room. Room temperature was maintained between 76 and 80 degrees Fahrenheit. After an infant was brought to the exam room, it was observed for a period of two minutes at which time state changes, color, skin condition, and spontaneous movements were recorded. While the infant remained in its bassenette, the response decrement items were administered. A flashlight was flicked across the baby's closed eyes for one second and the response was observed. About five second intervals separated each stimulus. This was repeated until no response continued unabated after ten trials. Next the examiner waited, if necessary, for the baby to quiet upon which the rattle was shaken approximately six inches from the subjects most exposed ear and the response recorded. This procedure, as well as the bell that followed, was administered for the same number of trials as the flashlight and to the same criterion. The infant was then uncovered and observed for fifteen seconds for spontaneous reactions to the uncovering. This was followed by a mild pinprick to the sole of the foot. Response level, state changes, and self-quieting behavior were all scored after each trial. A maximum of five pinpricks were administered. After this the infant was placed supine on the examination table. A brief observation period followed. Up to this point, the infant usually remained in a sleep

state, however, being placed upon the examination table sometimes elicited crying. When crying occurred, the examiner waited before standard consolability measures were used. The standard procedure for consoling the infant began with the presentation of the examiner's face to the infant, then speaking to the infant, placing a hand on the infant's abdomen, restraining one arm then restraining both arms. If these maneuvers were unsuccessful in quieting the infant, a major consoling effort was made.

The following maneuvers were usually done in a somewhat standard sequence although considerable flexibility is allowed since the infant is not always in the appropriate state for a particular item. Therefore, from this point on it was the responsibility of the examiner to watch closely for state changes that allowed for the optimal response to a state dependent item.

While the infant was still dressed ankle clonus, plantar, Babinski reflex and tonus of the legs were evaluated. The shirt was removed and then in the following order the palmar grasp, pull to sit, rooting, sucking and glabella reflexes were elicited. The next group of responses were orientations to auditory, visual, inanimate, and animate stimuli. Ideally, the infant's head should be in midline for these procedures. They proceeded in the following order; orientation to the bell, where the bell was continually rung about six inches from the baby's ear, visual inanimate where the infant was allowed to fixate on the red and white ball. The ball was held approximately eight to ten inches from the infant's eyes and

moved across the infant's visual field. In orientation to face, the examiner presented his or her face to the infant about eight to ten inches from the infant's face and again moved slowly across the infant's visual field. Orientation to voice required the examiner to speak into the ear of the infant until a response was obtained. Orientation to face and voice required the examiner to present his or her face in the same manner as before but also to talk to the infant. An attempt was made to get the infant to visually follow this combination of human stimulation. In all of these orientation items the duration, steadiness, and degree of following or head turning was observed. A group of motor reflexes which followed include standing, walking, and placing. Next body tone, spontaneous head control, and crawling were all observed while the infant was in a prone position. Then the infant was cuddled in the examiner's arms and the degree to which the infant molds and cuddles was assessed. These were followed by the spin maneuver where the infant was held supine across the examiner's arm and spun 360 degrees to the left and to the right. The infant's general body tone was assessed following the spin and then Moro reflex was elicited. Next the infant was cuddled at the shoulder of the examiner and then placed supine on the exam table. For the defensive movements a small cloth (usually the infant's shirt) was placed over the upper part of the face to partially cover the infant's nose until the infant responds with a series of responses, e.g., general quieting, mouthing, etc.

The final elicited response was the tonic-neck-reflex which was performed by turning the infant's head ninety degrees from midline

to the left or right and held in position for five seconds. The characteristic response was an extension of the ipsilateral leg and arm, and flexion of the contralateral leg and arm. Following these procedures the infant was dressed, put back into its crib, and returned to the nursery.

Instrumentation for Fetal Heart Rate Monitoring

Routine methods for fetal heart rate monitoring (Hon 1975) were used to monitor each subject. Labor and delivery room personnel were responsible for preparing each patient and collecting the fetal heart rate tracings. Both external and internal monitoring techniques, Hon (1975), were used. The data were generated from a Corometrics Central Display Model 414 and Memory Selector Model 407 were also used. An instantaneous (non-averaging) cariotachometer with a linear fetal heart rate presentation over a range of 50-210 bpm recorded the cardiac signal on standard Corometric FHR chart paper at a speed of 3.0 cm/sec.

Fetal Heart Rate Data Collection

The original fetal heart rate tracings on a total of 120 of the 144 subjects given the Brazelton Scale were obtained. Subjects were identified by the hospital number of the mother and the date of delivery. This made it possible to secure the fetal heart rate information without any systematic knowledge of the subjects performance in the Brazelton Scale. Further, none of the tracings were analyzed until the entire sample had been obtained. Because some of the

tracings were recorded using external monitoring techniques, and these tracings are sometimes distorted because of maternal or fetal movements, only those external tracings that were comparable in quality to internal tracings were retained for analysis. This resulted in the loss of 18 tracings. Twelve more tracings were discarded because of incomplete drug information. A total of 90 tracings were retained which comprised the sample for the last study. Each tracing was scored and classified for the 60 minute segment preceding delivery. This time was arbitrarily chosen due to a lack of uniformity in the literature for studies which report the time segment used. Low et al. (1977) have indicated that the last two hours prior to delivery show the most significant differences between compromised and uncompromised fetuses. However, Cibils (1975; 1976) used 60 minutes as a minimum while Rochard et al. (1976) used only 30 minutes.

Since heart rate data were not obtained on every subject, the question arose whether the missing data were systematically related to high risk factors. Because monitoring is a routine practice in the hospital, and only patients who refused were not monitored, it was assumed that unavailable data were due to random causes.

Fetal Heart Rate Data Reduction

In an effort to obtain and use as much of the fetal heart rate information as possible, a system of scoring each tracing was developed. This method generated a total of eighteen measures for each record. The scoring system will be described on the following page.

There were four measures of absolute frequency and one percentage measure. Three of these measures had not been reported in the literature:

- a) absolute frequency of accelerations ≥ 15 bpm
- b) absolute frequency of decelerations ≥ 15 bpm
- c) absolute frequency of uterine contraction
- d) total frequency of heart rate changes ≥ 15 bpm from baseline
- e) percentage of uterine contractions that were accompanied by an acceleration or deceleration

There were also five measures of magnitude which supplied the mean values for heart rate deviations from baseline. These values were determined by calculating the mean values for the highest and lowest peak of a heart rate change. They were:

- a) mean absolute value of the accelerations
- b) mean absolute value of the decelerations
- c) mean absolute value of the difference between accelerations and baseline rate
- d) mean absolute value of the difference between decelerations and baseline rate
- e) mean absolute difference between the mean of the accelerations and mean of the decelerations

There were two measures of baseline activity.

- a) baseline heart rate averaged over the interval between contractions. These measures were taken only if there were no accelerations or decelerations ≥ 15 bpm during the interval.
- b) baseline variability or beat-to-beat variability averaged over four minutes and between contractions. Time segments with no accelerations or decelerations > 15 bpm.

The baseline values were calculated by averaging the highest and lowest values of baseline for each four minute segments of a tracing.

The mean of these averages was then computed for the overall baseline. The variability scores were similarly obtained by averaging the highest and lowest peaks in heart rate (as distinct from accelerations and decelerations) for each four minute segment of a tracing. A complexity measure was also included in the analysis in an effort to represent some of the qualitative characteristics of the fetal heart rate pattern. A composite complexity score was obtained by totaling the number of different patterns or changes which occurred in a record. The qualitative variables were accelerations, decelerations, late decelerations, sinusoidal and biphasic. The complexity score ranged from zero, indicating no qualitative changes, to a maximum of five in a record where all five patterns were observed. Separate scoring was also done for the presence or absence of late decelerations, sinusoidal, and biphasic patterns. Finally, a score for two other variables thought to exert an influence upon fetal heart rate patterns were included:

- a) length of labor (hrs.)
- b) amount of drugs

An explanation regarding the score for drugs is necessary. In this study, control over the amount of drugs given to the mother is least systematic. Summing the number of different drugs administered to the mother does not adequately explain much about the effects of combined medication. A weighting system using the standard dosage for each drug as the unit of measurement was employed. By totaling units, a value for drug dosage was obtained. It is recognized that this system has limitations but has advantages over simply adding the number

of different drugs administered. To illustrate how this was achieved an example may help. A standard dosage for drug X in our sample was 25 mg. The standard dosage for drug Y is 50 mg. A mother is given a total of 75 mg. of drug X and 100 mg. of drug Y. This result is a drug score of 5 for this subject; three units of drug X and two units of drug Y.

CHAPTER FIVE RESULTS

Study I

Study I was carried out as a pilot study. The purpose was to explore the relationship between newborn birth weight and performance on the Brazelton Scale using multivariate statistical procedures.¹ The preliminary study consisted of 52 newborns who were divided into full and low birth weight groups. Table I shows the means and standard deviations for the descriptive characteristics of the sample. The low birth weight infants were significantly lighter, $F(1,46)=87.09$, $p < .001$, shorter, $F(1,46)=25.02$, $p < .001$, and had a smaller head circumference, $F(1,48)=28.26$, $p < .001$, than the full birth weight babies. The mean gestational age was also shorter in low than in full birth weight infants, $F(1,48)=15.68$, $p < .001$.

The risk factors included five minute Apgar scores, birth order, gestational age, birth weight, age of the mother and type of obstetric medication. These factors were chosen either because previous investigations have found them to affect behavior independent of birth weight, as in the case of obstetric medication, or because of the association between the factor and low birth weight. The factors of age of mother and birth order, for example, are each associated with low birth weight and interact. Therefore, the highest rates of low birth weight are found among the never before pregnant or the

¹ Portions of study I were reported by Lester, Emory, Hoffman and Eitzman (1976).

Table 1

Descriptive Characteristics of the Pilot Sample

Variable	Low birth weight		Full birth weight	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
Birth weight (gms.)	2352.00	219.50	3099.50	238.64
Length (Cms.)	47.20	2.40	50.90	2.10
Head Size (cms)	31.80	1.40	34.00	1.17
Gestational age (Wks)	37.10	2.53	37.70	1.07
Apgar	9.00	.75	8.85	1.50
Age of mother	19.85	4.00	22.00	5.70
Birth order	1.79	.64	2.35	1.50

too-often-pregnant young mother and in mothers who are over 30 and/or a parity greater than four particularly for the lower social strata (Birch & Gusow 1970).

In an effort to reduce the various scale items of the Brazelton Scale to a few conceptually distinct dimensions, a factor analysis was performed. The first analysis on this sample of 52 newborns was a principle components analysis (varimax rotation) on the 27x27 intercorrelation matrix of the Brazelton Scale items. Table 2 shows the items that defined each factor with their associated factor loadings. Only factor loadings above .32 were used. Two factors which accounted for more than 10 percent of the variance will be discussed. Factor 1 accounted for 20 percent of the variance and was composed of eight items along a dimension of attention-orientation. Factor 2 was composed of seven items along a dimension of temperament-arousal and accounted for 18 percent of variance. The results of the factor analysis were transformed such that each subject was assigned a summary score based on the raw scores of the items that defined the attention-orientation and temperament-arousal factors. Thus, each subject received a composite factor score for Factor 1 and a score for Factor 2. The average intercorrelation among the items composing the summary scores was $r=.43$, $p < .05$, for attention-orientation, and $r=.38$, $p < .05$ for temperament-arousal. The correlation between the two composite scores was not significant, $r=.18$.

The next step in the analysis was to examine the effects of our high risk factors on the Brazelton factors. To accomplish this a summary score for items in each factor was computed for each subject.

Table 2

Factor Loadings for Items Defining the Attention-Orientation and Arousal-Temperament Factors on the Brazelton Newborn Assessment Scale

Study I

Factor 1		Factor 2	
Attention-Orientation		Arousal-Temperament	
Item	Loading	Item	Loading
Inanimate visual	.80	Consolability	-.48
Inanimate auditory	.70	Peak of excitement	.92
Animate visual	.70	Rapidity of buildup	.78
Animate auditory	.56	Irritability	.84
Animate visual & auditory	.75	Lability of skin color	.43
Alertness	.76	Lability of state	.49
Muscle tonus	.49	Self-quieting	-.39

The summary score was then entered into a multiple regression equation as the dependent variable with the high risk factors as predictor variables entered stepwise. The linear combination of the eight predictor variables significantly predicted scores on the attention-orientation factor. Birth weight was found to be the best single predictor of the attention-orientation factor, $R^2=.09$, $F(1,48)=4.86$, $p < .03$. In the final regression model in which all factors were included the overall regression coefficient was significant, $R^2 = .37$, $F(8,41)=3.00$, $p < .01$. Specific effects were found for birth weight, $F(1,41)=8.62$, $p < .005$; age of mother, $F(1,41)=6.50$, $p < .01$; sex, $F(1,41)=4.68$, $p < .03$; and race $F(1,41)=4.86$, $p < .03$. Lower scores on the attention orientation factor were associated with lower birth weight babies and infants of younger mothers. Higher scores were found for female than for male babies and white than black infants. The results for the regression on the temperament arousal factor showed the Apgar score to be the best single predictor, $R^2=.08$, $F(1,48)=4.22$, $p < .04$. High Apgar babies scored higher on the temperament-arousal dimension than lower Apgar babies. The linear combination of the seven predictor variables was not significant for this factor.

Study II

Study II was designed to determine the stability and reliability of the factors found in Study I and to compare the mean Brazelton Scale differences among the three birth weight groups.²

² Portions of Study II were presented at the Conference on Human Development, Nashville, Tennessee, April 1976.

Study II included the subject in Study I plus ninety-two new subjects from the same general population. Table 3 shows the mean and standard deviations for the larger sample of 144 subjects. In addition to the significant differences among birth weight groups in weight, there were also significant differences for the headsize, $F(2,129)=32.27$, $p < .001$, length, $F(2,131)=38.73$, $p < .001$, mother's age, $F(2,135)=3.97$, $p < .02$, birth order, $F(2,128)=5.10$, $p < .007$. The mean gestational age was also different for the three birth weight groups. $F(2,128)=28.14$, $p < .001$. Mother's height and age of menarche was not significantly different for the three birth weight groups.

A second principle component factor analysis with varimax rotation for the larger sample was performed on the 27x27 intercorrelation matrix of Brazelton items. Eight factors were generated from the factor analysis. Three factors which accounted for at least 10 percent of the variance will be discussed. Table 4 shows the items that defined the three main factors in Study I and their associated factor loadings. Factor 1 which we called attention-orientation contained six items and accounted for 31 percent of the variance. Factor 2 accounted for 20 percent of the variance and included five items along a dimension of arousal. Factor 3 was composed of five items along a dimension of temperament and accounted for 13 percent of the variance. Table 5 lists the items that loaded on the two main factors in Study I that were included in Factors 1, 2 and 3 in the second study. Six of the seven items that defined Factor 2 in the first study were included in Factors 2 and 3 in the second study. I

Table 3

Descriptive Characteristics of the Sample
Study II

Variable	Low birth weight		Full birth weight		High birth weight	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
Birth weight (gms)	2112.50	368.21	3185.00	358.50	4188.40	377.50
Head size (cm)	31.7	1.4	34.8	2.6	35.9	1.4
Length (cm)	46.3	2.3	50.4	4.8	55.2	2.3
Gestational age (wks)	36.0	3.5	38.0	1.6	40.1	1.9
Birth order	2.2	1.6	1.9	1.3	3.0	1.4
Age of mother	20.5	3.8	20.9	5.4	23.8	5.4
Mother's height	61.5	2.9	62.5	2.0	62.8	3.3
Age of Menarche	12.6	1.2	12.1	2.5	12.0	2.8

Table 4
Factor Loadings for Defining the Attention-Orientation, Temperament
and Arousal Factor on the Brazelton Newborn Assessment Scale

Factor 1 Attention-Orientation	Factor 2 Temperament		Factor 3 Arousal	
	Item	Loading	Item	Loading
Inanimate auditory	Inanimate visual	.62	Pinprick	.52
Animate visual	Peak of excitement	.78	Consolability	.64
Animate auditory	Rapidity of buildup	.58	Startles	.72
Alertness	Irritability	.86	Lability of state	.51
Defensive movements		.61	Self-quieting	.73

Table 5

Items from the Brazelton Newborn Assessment Scale that Loaded on Factors
In Study I and II

Factor 1	Factor 2	Factor 3
Item	Item	Item
Inanimate auditory	Inanimate visual	Consolability
Animate visual	Peak of excitement	Lability of state
Animate auditory	Rapidity of Buildup	Self-quieting
Animate visual and auditory	Irritability	Alertness

labeled Factor 2 Temperament-Arousal in Study I and this factor seems to have split into two separate factors with the second larger sample. It is not immediately clear why inanimate visual which loaded heavily on Factor 1 in Study I shifted to Factor 2 in Study II. The addition of a birth weight group and the increase in sample size may have accounted for this shift.

The results of the second factor analysis were used in an analysis of variance to examine the relationship between birth weight and the factor scores. To accomplish this we computed a composite score for each subject using the raw scores for each item that comprised the factor. In other words, each subject received a score for attention-orientation, a score for arousal, and a score for temperament. The average intercorrelation among the items composing the summary scores was $r=.35$, for attention-orientation, $r=.30$, for temperament and $r=.42$, for arousal. To test for the effects of birth weight we performed a 3 (birth weight) $\times$ 2 (sex) analysis of variance for each composite score with gestational age as the covariate.

The results for the attention-orientation factor showed a significant main effect for birthweight, $F(1,109)=3.46$, $p < .03$. The mean attention-orientation score for the full birth weight group was higher than the mean score for the low and high birth weight groups. There was a significant sex $\times$ birth weight interaction for Factor 2, $F(2,100)=3.84$, $p < .02$. The mean temperament scores were higher for the low birth weight males and high birth weight females than for the other groups. Factor 3 also showed a significant sex $\times$ birth weight interaction, $F(2,73)=3.80$, $p < .03$. This was due to higher arousal scores

for low birth weight males and high birth weight females than for the other groups.

Study III

The objective of study three in this series was to determine the pattern of relationships among the 17 fetal heart rate variables and their relationship to the Brazelton factor scores. Table 6 shows the descriptive statistics for the sample in Study III. All fetal heart rate variables had approximately normal distributions. Inspection of the correlation matrix revealed that only two correlations were above .7 and none above .8. This suggested that several factors would be necessary to describe the domain. It appeared at first that the variable drugs, labor, and percentage of change had low correlations with the other variables and might need to be discarded. However, only the variable percentage of change showed no correlation with the other variables. Because of this, percentage of change was not included in the analysis. This meant that 17 variables were retained for the subsequent analysis.

A principle components analysis yielded six factors with eigenvalues greater than 1.0 (Kaiser 1960, 1965) suggesting that a six-factor solution would adequately describe the relationship of the variables in the analysis.

Factor analysis using estimated communalities (e.g., estimated shared or common variance across two or more variables) derived from squared multiple correlations, principal factoring with iterations,

Table 6
Descriptive Statistics for Sample
Study III

Variable	Low birth weight		Full birth weight		High birth weight	
	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
Birth weight	1986.37	337.42	2821.64	361.41	4189.23	381.32
Head size (cm)	31.9	1.3	34.3	1.7	36.0	1.3
Length (cm)	46.9	2.1	50.9	2.2	55.4	2.2
Gestational age (wks)	36.0	3.9	38.1	1.6	40.3	2.3
Birthorder	1.9	1.2	1.5	1.1	2.7	1.4
Mother's age	20.3	4.0	20.4	5.0	23.2	5.8
Age of Menarche	12.7	1.1	12.7	1.3	12.6	1.3
Mother's height	61.3	3.3	62.0	2.1	62.6	1.9

and varimax rotation (Nei, Bent & Hall 1970) were performed assuming 5 to 7 factors. Interpretability suggested that six-factor solution was optimal. Thus, the results of a six-factor solution will be reported.

The fetal heart rate (FHR) variables and their corresponding loadings on each factor can be seen in Table 7. Only loadings above .39 were used.

Factor 1 is loaded heavily by three magnitude measures related to decelerations. Two of these loadings are high, $>.80$, while the third is negative.

Factor 2 has four positive loadings, three of which are complexity variables. Thus, this factor seems to be a complexity factor. Factor 3 has only two loadings. Both of these are frequency variables making factor 3 a frequency factor.

Factor 4 is loaded very highly by the baserate variable and only moderately by the mean of the decelerations, suggesting that this is a baserate factor. Factor 5 comprises three variables, all of which include an acceleratory component. This factor therefore seems to be an acceleration factor.

Factor 6, the last factor, is loaded positively by the labor and drug variables. It also shows a negative loading for variability suggesting that variability would best describe this factor.

Figure I is the tracing of a fetal heart rate pattern (upper trace) without any definable heart rate changes with contractions. The lower trace shows uterine contractions recorded in mm Hg. Baseline heart rate for the segment is 124 bpm with a variability of

Table 7
Fetal Heart Rate Factors and Variable Loadings

Variable	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6
Base rate	.12	.04	.02	.87*	-.16	-.36
variability	.04	-.26	-.04	.07	-.00	-.40*
freq-contract	.09	-.43*	.08	.04	-.12	-.12
freq-heart chg.	.13	.25	.86*	-.05	.38	.06
freq-accel	.16	-.03	.16	-.23	.24	.09
freq-decel	.13	.23	.78*	.02	-.04	-.07
mean-accel	-.24	-.25	.21	.15	.57*	-.20
mean-decel	-.67*	.07	-.07	.50*	.24	.23
accel-diff	.25	.00	-.14	-.26	.53*	-.24
decel-diff	.82*	-.04	.18	.17	-.11	-.01
accel-decel-diff	.92*	.23	.05	.01	.17	.02
sinuous	-.10	.22	.10	-.10	.42*	.07
biphasic	-.20	.58*	.26	-.11	-.11	.08
late decel	.09	.66*	.15	.14	.11	-.03
complexity	.11	.72*	.00	-.26	.09	.42*
drugs	-.10	-.01	-.00	.00	-.12	.39*
labor	.08	-.07	-.03	.02	.04	.59*

* loadings greater than .39

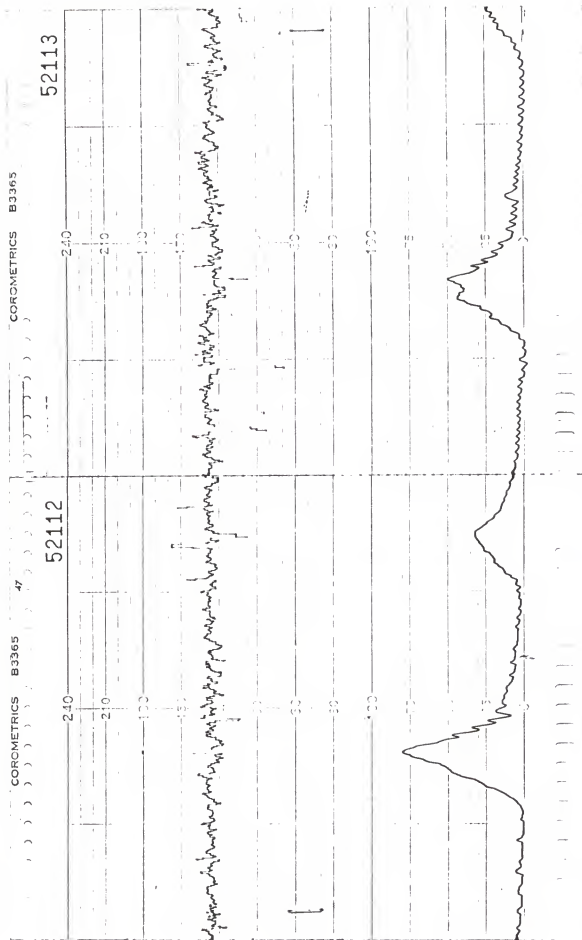


Fig. 1. Fetal heart rate showing good variability and minimal changes with contractions.

17.3 bpm. In this tracing there are no detectable ominous signs of fetal vulnerability to labor. Figures II through VI illustrate several ominous fetal heart rate patterns.

In an effort to explore the relationship between the behavioral dimensions of the Brazelton Scale reported in Study II, the six fetal heart rate composites were used as predictor variables. Due to the modest sample size and relatively large number of variables, composite scores were used to avoid substantial capitalization on chance. Attention therefore is confined to the three behavioral factors and six fetal heart rate composites. Factor scores for the FHR factors were obtained by assigning variables to factors on the basis of their highest factor loading.

Three separate step-wise multiple regression analyses were done in an effort to predict the behavioral composites from the FHR factors. Although the step-wise procedure may capitalize on chance with samples of less than 200 cases (Cooley & Lohnes 1971), the decision to use this procedure was based on the exploratory nature of the study and the conceptual benefits it might offer for interpreting the FHR-behavioral relationship.

By using the six FHR factor composites to predict the attention-orientation factor, the obtained R was .42 (p .01). The predictor variables in order of beta weights were decelerations, baserates, accelerations, and frequency.

The factor composites used to predict the temperament factor was not significant, $R=.24$.

Figure II

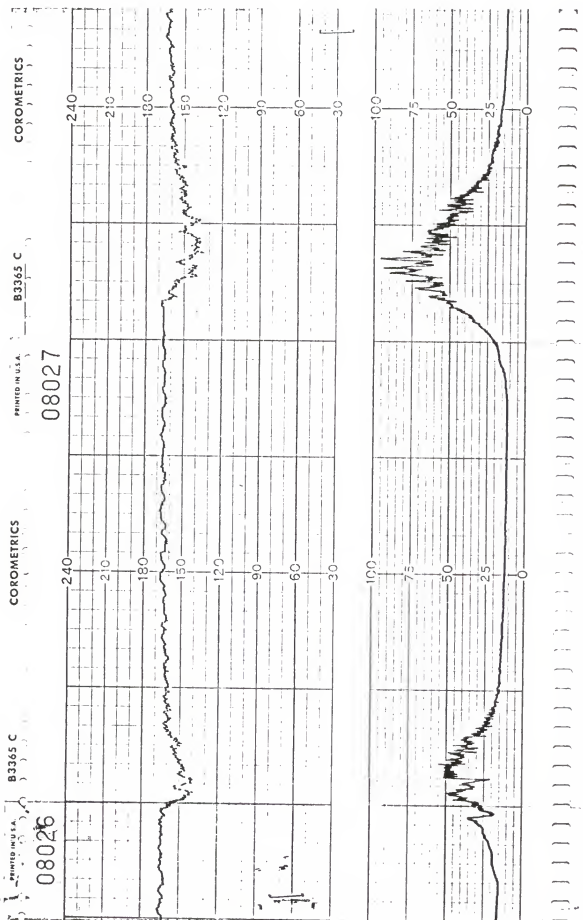


Fig. II. Pattern with high baseline rate, low variability, and uniform decelerations with contractions.

Figure III.

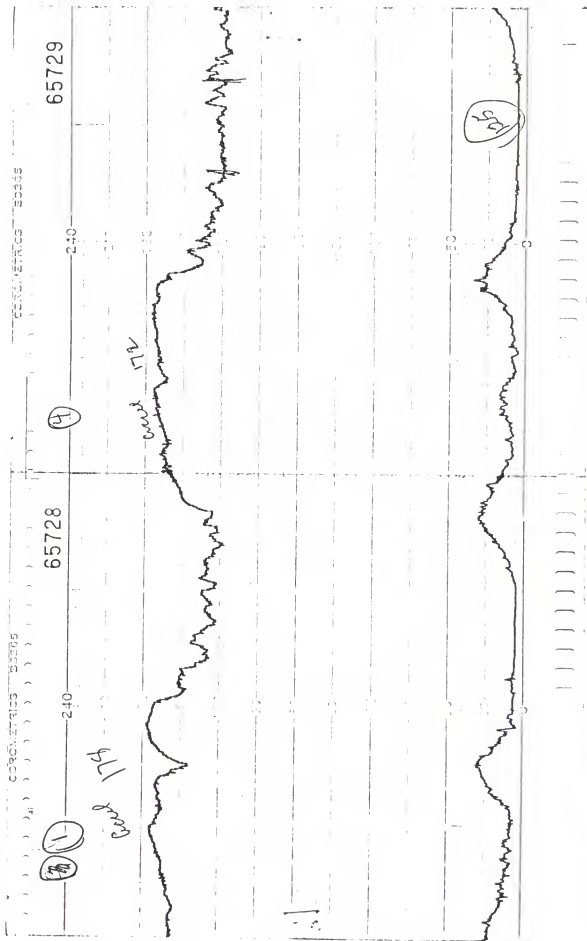


Fig. III. Pattern with accelerations extending over two minute period.

Figure IV

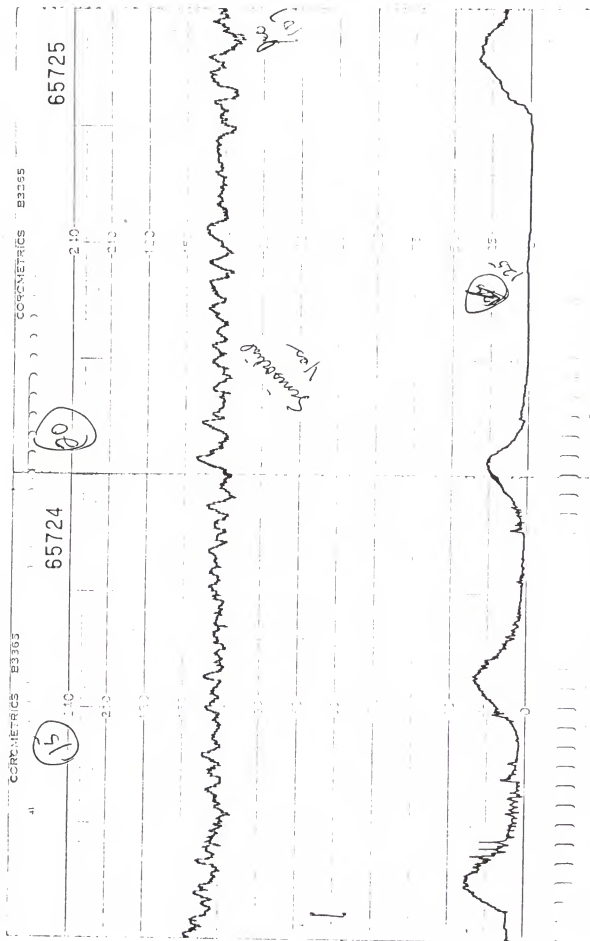


Fig. IV. Baseline rate maintained around 120 bpm. with sinusoidal characteristics.

Figure V.

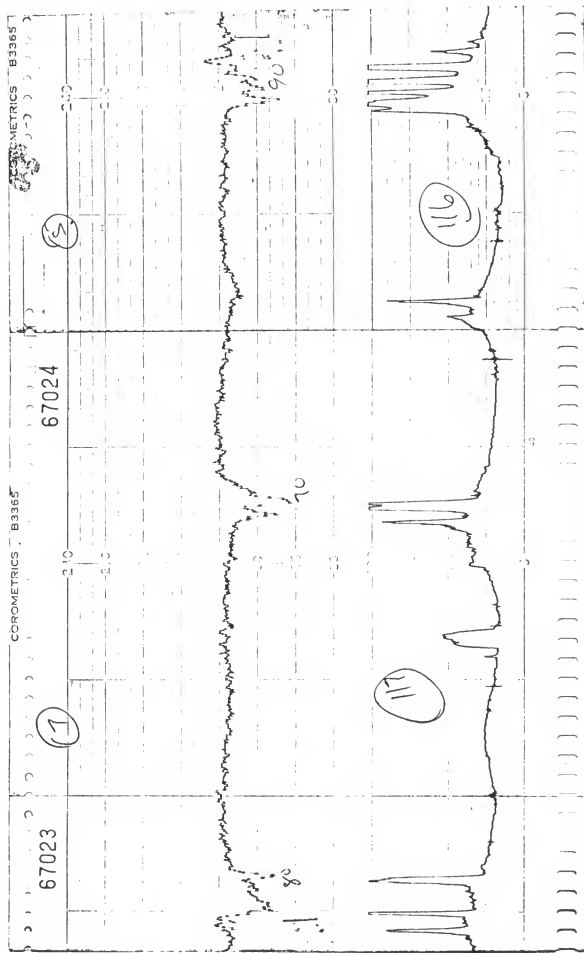


Fig. V. Pattern showing diminished baseline rate and uniform decelerations.

Figure VI.

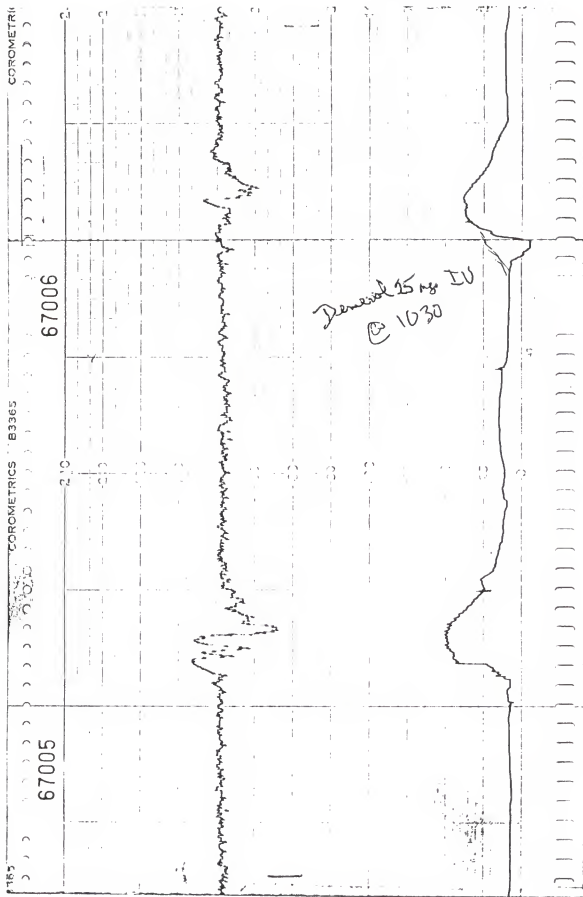


Fig. VI. Diminished baseline rate and biphasic heart rate changes with contractions.

When the factor composites were used to predict the arousal factor, the obtained R was .46 ($p < .05$). Table 8 shows the multiple regression weights of the FHR factor composites for the behavioral criteria.

In order to explore further the pattern of relationships among the items of the attention-orientation composites and arousal factor, canonical correlation analysis was performed. The results indicate that neither of these canonical correlates were significant at the .05 level.

Finally, an analysis of variance was performed on each FHR composite with birth weight as the independent variable. None of the analysis of variance tests were significant. Birth weight was normally distributed in the final sample. Therefore it appears that fetal heart rate patterns were not significantly affected by birth weight in this study.

Table 8
Multiple Regression Weights
of FHR Components and Brazelton Criteria

Attention-Orientation Factor		Arousal Factor	
FHR Composite	Beta weight	FHR Composite	Beta weight
deceleration	-.34	deceleration	-.51
baserate	-.33	baserate	-.21
acceleration	-.19	complexity	-.25
frequency	-.01	frequency	.22
		variability	-.16
		acceleration	.11

CHAPTER SIX DISCUSSION

The results of Study I suggested that birth weight is a useful variable for predicting scores on the Brazelton Assessment Scale with low and full sized newborns. Study I also suggests that the use of multivariate regression techniques may aid in this prediction. However, in the initial study it was also found that birth weight did not significantly predict Brazelton scores related to the temperament arousal factor. Thus, Study II was conducted to help clarify these findings and determine if the relationship between the factors, as well as the factor structure itself would remain if the birth weight categories were extended to include large newborns as well. The results of the second factor analysis of the Brazelton Scale on a larger sample drawn from the same population suggest that the temperament-arousal factor actually represented two distinct but similar dimensions of newborn behavior. It is possible that these dimensions were not discretely identified because of the sample size in Study I. It is also interesting to note (Tables 4 and 5) that six items which loaded on Factor 2 and Factor 3 from the original temperament-arousal factor in Study I split evenly on the temperament and arousal factors in the second study. In other words, three of the six items loaded on Factor 2 while the other three loaded on Factor 3. The results of Study II are compatible with the factor structure of the Brazelton Scale reported by Scarr & Williams (1971) and those reported in Study I. Moreover, Study II demonstrates

the stability of the attention-orientation factor as a reliable behavioral dimension to which the Brazelton Scale is sensitive. Based on the results of Study II it appears that the Brazelton Scale dimensions may have been globally represented in previous studies. This may have been due to the small sample size in other studies (Scarr & Williams 1971; Soule et al. 1974). With the sample size in Study II it was possible to identify three separate factors relating to distinct behavioral patterns.

The arousal factor appears to sample the spontaneous accessibility and responsivity of the neonate to various forms of stimulation. The strength and character of these reactions may be dependent upon the neonate's ability to respond to the immediate environment. Whereas the arousal dimension may reflect the neonate's responsiveness to internally or externally aversive stimuli, the temperament factors may represent a more characteristic style of responding to socially relevant stimuli. This type of responding may be similar to that suggested by others (Thomas, Chess & Birch 1968; Korner 1971) regarding temperamental differences in infancy and early childhood.

The significant birth weight effects obtained in Study II from the analysis of variance are consistent with other studies in which low birth weight infants show differences in behavior when compared to full sized newborns (Caputo & Mandell 1970). Of greater interest and possible significance are the effects of high birth weight on the attention-orientation factor. Not only were the large babies responding differently than average sized infants, their scores on

attention-orientation factor as similar to those of low birth weight infants. A point to be emphasized here is that the large newborns in this study were not considered post-mature. Further, studies dealing with birth weight as an independent variable are often subject to criticism since they may fail to control for gestational age (Drillien 1964). Since the covariations in Brazelton scores for this sample was partially controlled for by design as well as statistically, the results suggest that high birth weight may leave the same behavioral consequences as low birth weight. For example, the post-mature newborn who is of appropriate birth weight may exhibit precocity in its alerting behavior (Vaughan & McKay 1975). The high birth weight sample in this study showed attentional patterns similar to those newborns of low weight status. One may speculate that the behavioral consequences of accelerated intrauterine growth are similar to retarded fetal growth.

The results of Study II provided additional information on the influence of birth weight upon newborn behavior. However, both studies left many questions unanswered. The Brazelton Scale has become a very popular newborn assessment technique but has received limited attention regarding test validity. The studies that have been conducted speak highly of the scale's discriminative value. The somewhat subjective nature of behavioral assessment scales suggests that their validity could be enhanced by use with other measures of fetal or neonatal functioning. Study III was designed to explore the possible relationship between the results obtained from the administration of the

Brazelton Scale with a more objective physiologic measure of fetal functioning. The task was simplified because fetal heart rate data from delivery were available on many of our Brazelton subjects. Secondly, some of the methodological problems inherent in studies of autonomic functioning in the newborn could easily be overcome. Third, the stimulus, although not under the control of the experimenter, was easily definable and quantifiable. Moreover, the fetal heart rate data seemed appropriate for the application of multivariate techniques.

The goal of the factor analysis of fetal heart rate patterns was to inquire into the dimensions of the FHR domain. The obtained structure, although tentative, represents an initial attempt which may lead to further investigation. It is not clear why variables such as late decelerations and variability load on different factors. However, it is also not specifically known how these variables might interact with each other. The labels given to the factors are therefore descriptive rather than conceptual as future attempts may uncover other structures or dimensions. These results clearly designate factors which describe different aspects of the fetal heart rate responses to labor. This is illustrated by the type of variables that load heavily on the factors. Deceleration measures load on Factor 1, all of which have high correlations. Factor 2 is defined by complexity variables and a frequency variable. Factor 5 has high loadings on two acceleration variables. It is not immediately clear why the sinusoidal variable loaded on this factor. One explanation is that this pattern quantitatively reflects acceleration components of the fetal heart rate

waveform. Also the sinisodal pattern was not usually associated with decelerations or a low baserate. Factor 6 has high loadings on drugs and length of labor. Both of these variables are considered to affect fetal stability. It is not surprising that baseline variability loads negatively on Factor 6 since it is affected by drugs and the length of labor.

Two factors with high loading for only two variables were observed. Factor 3 shows a strong correlation, .75 between these two variables in the correlation matrix. Subsequently their loadings on Factor 3 may be less likely artifactual than the variables loading on Factor 4. In Factor 4 inspection of the correlation matrix shows a weaker, .33 correlation. Subsequent analysis may consider additional measures which could result in some new factors.

With the tentative factor structure resulting from the analysis of the fetal heart rate variables, the next question considered was the relationship, if any, between the multiple FHR responses and performance on the Brazelton Neonatal Assessment Scale. From the overall results, it seems that the relationship between the FHR and behavioral measures is quite strong in this sample. The magnitude of the relationship suggests that the two sets of measures may account for different components of variance that could have empirical benefits. The FHR and behavioral measures may actually constitute complementary predictors of later development. This is suggested because the analysis of variance on the fetal heart rate patterns were not found to be significantly related to birth weight. Birth weight and fetal heart

patterns may therefore account for independent influences upon neonatal behavior. Specifically these results may have implications for understanding the effects of early physiologic stressors upon later cognitive and behavioral functioning. Fetal heart rate responses to labor may be reflecting the fetuses' tolerance for stress. It is important to consider that the FHR variables predicted both the attention-orientation and arousal factors of the Brazelton Scale but not the temperament factor. It may be that fetal heart rate patterns which reflect autonomic and regulatory functions are manifested via the behavioral responses which are found on the attention-orientation and arousal factors. The homeostatic mechanisms which are involved might also influence the quality and quantity of attentional processes. On the other hand temperamental characteristics may be more genetically influenced. The cross-cultural studies (Brazelton & Koslowski 1976; Freedman & Freedman 1969; Brazelton 1972) of newborn infants support this interpretation. However, cross-validation and replication studies of the FHR-behavioral relationship are needed to support this claim. Therefore these results, although significant, are not conclusive. Moreover, the stability of the FHR factors needs support from other studies. On the other hand, the potential utility of these sets of measurements as predictive tools should not be overlooked.

Methodological Issues in the Use of the Brazelton Scale

Whenever a new test is developed attention usually focuses upon the validity and reliability of those observations. It is therefore appropriate to consider the question of validity when one observes

newborn performance on the Brazelton Scale. These conceptual questions have not received a great deal of attention in newborn research as behaviors other than reflexes have been virtually ignored. As the use of behavioral assessments of the newborn continue to increase, it will become necessary to face the issue of validity. What, for example, is the significance of observing that one newborn will visually focus upon and track a moving object and another one will not? Does the finding that some neonates are irritable or show considerable lability of states suggest that they are different, in a meaningful sense, than the more passive newborn who exhibits fewer state changes over a comparable period? Thomas, Chess & Birch (1968) suggest that temperament, which they define as the overt behavioral style of the individual child, constitutes one of the basic factors in development. These authors are not alone in their belief. Korner (1971) has described characteristics of the newborn which reflect an enduring style of individual reaction patterns and the logical cohesion of adaptive efforts. Thus, as we return to the question of validity it can be said that behavior in the newborn period may be meaningful in terms of how an infant, given a particular set of reinforcing experiential conditions, will come to favor the later adoption of certain modes of impulse management, later cognitive styles, and characterological attributes. Much of the research in newborn behavior will be concerned with predictive implications. Also validity based upon predicted outcome carry substantial impact when issues related to intervention strategies and behavioral management are of primary concern. A major

concern of the behavioral scientist is the prediction and control of behavior. Results and findings based purely on predictive validity may obscure the underlying behavioral determinants as prediction may lack explanatory power. However, as is commonly necessary in psychological research, the investigator becomes engaged in construct validation. This is necessary when a test is interpreted as a measure of some attribute or quality which is not "operationally" defined (Chronback & Meehl 1955). In human newborn research the investigator may be faced with a situation where no criterion is fully acceptable to him. Such a condition currently exist in the assessment of newborn behavior. What has become a common practice is the establishment of test validity on the basis of empirical discrimination between patient groups e.g., experimental groups and normals.

Much of the published research using the Brazelton Scale can be considered discriminative validity studies. Subsequently, the scale is open to several questions. What does it really measure? Does it measure social behavior, attention, temperament, or central nervous system maturity? These questions are intimately related to construct validity and are of central importance to the investigator using such instruments. Consequently, it is advisable to consider validity questions when interpreting behavioral results. It follows that decisions regarding the choice of an instrument for newborn behavioral assessment take validity questions into account. It is not within the scope of this discussion to determine what type of validity has been established with the Brazelton Scale. The current investigation, however, may have some implications for the validity of the Brazelton Scale.

The Use of Multivariate Statistical Techniques in the Study of Newborns

Although the following topic was discussed in previous sections, it is important to emphasize again because of the questions which are being addressed in the present study.

Of considerable concern to the behavioral scientist interested in neonatal functioning is the extent to which factors associated with birth may alter the capabilities of the neonate in responding appropriately to its environment. These factors may be represented by a number of agents covering the spectrum from actual physical trauma, often affecting the central nervous system, to molecular changes in biochemistry. Any one of these factors may have effects upon the newborn. It is also likely that several of these factors operating interdependently may produce deviant behavioral patterns (Soule et al. 1974). As a research problem this interaction can become very thorny as it is often difficult to isolate the causal agent. Even when causality can be specifically inferred, ethical considerations mitigate against certain experimental manipulations with human subjects. Therefore, it becomes important that investigators interested in exploring the various relationships among perinatal factors and newborn behavior be able to determine the relative contribution of factors affecting the newborn. It becomes possible to determine with greater accuracy the degree of risk associated with a particular set of perinatal circumstances. It may also be possible to discover the behavioral sequelae associated to them. Multivariate statistical techniques make it possible to separate effects that would be otherwise

statistically confounded with each other. It is expected that as these techniques (e.g., multiple regression, factor analysis, etc.) will become more widespread as researchers abandon strict laboratory paradigms to explore more complex behavioral phenomena.

CHAPTER SEVEN CONCLUSIONS

Approaches to the Study of Newborn Behavior

Single Variable Analysis

Single variable analysis of newborn behavioral capabilities often provide considerable information regarding infant abilities. Particular attention to auditory and visual systems have appeared in the literature for several decades (Appleton, Clifton, & Goldberg 1975). The major methodological orientations of these studies suggest that these systems are investigated as if they functioning independently. Conceptually such a notion can be maintained but empirically it would be difficult to substantiate. Therefore, the information that is obtained from single variables studies may have limited value when cross-modal and integrative capabilities are of primary interest. The study of single variables however, may be appropriate for laboratory investigations where causal variables are more easily identified and controlled. The experimental controls may be difficult for the applied researcher interested in multiple causes. Laboratory studies have limitations that can be delineated with some degree is specificity. The include the following:

- a) minimal accomodation for the fact that newborn behavioral systems function interdependently
- b) responses seldom approximate responses to natural environment
- c) maturation in one system may not parallel maturation in another
- d) prediction may have to be based upon functioning which is dependent upon more integrative capacities

- e) single variable studies often adhere to a simple cause effect model of behavior. Multiple causes may be operating.
- f) cause may become effect and effect may become cause

Dimensional Analysis

The approach taken in the current studies presume to study dimensional characteristics of newborn behavior. It does not preclude the potential usefulness of the single variable approach. It simply adheres to the premise that a dimensional analysis of some newborn functioning may provide information that cannot be obtained through univariate analysis. There are also several advantages to a dimensional approach when considering practical issues. Some of the salient advantages are listed below:

- a) dimensional analysis can provide a foundation for conceptualizing behavioral systems which are interrelated and interdependent
- b) as with the single variable approach, a dimensional approach may help to delineate essentially quantitative from qualitative changes during development
- c) a dimensional approach may more closely approximate functions which operate in the natural environment
- d) both approaches provide hypothesis regarding neurological and neurobehavioral development

Physiologic Responses

The study of physiologic response systems in the fetus and newborn have captured the attention of researchers for many years. Bernard and Sontag (1947) found that fetuses as young as seven months gestational age show heart rate accelerations in response to auditory stimulation. Since that time numerous studies of newborn and infant heart rate responses have appeared. Over the past decade

there has been a substantial increase in the evaluation of psychophysiological activity in early human life (Lipton, Steinschneider, & Richmond 1965; Steinschneider 1967). Specifically, it has become possible to exploit the activity of the autonomic nervous system as an interface between the scientist and the neonate (Hirschman & Katkin 1974). However, detailed studies of autonomic responses of the fetus have been limited by the relative inaccessibility of those systems which can be subjected to investigation. With the recent advances in fetal heart monitoring considerable data can be obtained regarding the response of the unborn fetus to intrauterine stress. Aside from the clinical value of this technique, the fetal response to labor may have implications for subsequent development. Additionally the stimulus for heart rate change in the fetus during labor (uterine contractions) is provided by nature and practically every newborn has been subjected to this condition. Conceptually fetal heart rate patterns during labor may provide a reliable basis for predicting later responses to various forms of environmental stress. Moreover, there may be a relationship between heart rate responses to labor and subsequent measures of heart rate to other forms of stimulation. The interrelationship of fetal heart rate with other autonomic functions provide yet another use of this measure. From a life-span developmental perspective the study of these variables require little justification.

The point of this brief discussion is that various levels of measurement and numerous responses, both autonomic and behavioral, are available for the study of the unborn and newborn infant. The choice

is strictly a decision of the investigator and will be guided by his or her theoretical interest. The orientation that has been adopted in these studies favor a dimensional analysis of both the behavioral and physiologic data. Some conclusive statements are warranted regarding the results.

The results of this series of studies suggest that:

- 1) birth weight is a significant predictor of behavior on the Brazelton Neonatal Assessment Scale
- 2) the behavioral responses of infants in this study are not necessarily a linear function of birth weight
- 3) a viable method for quantifying fetal heart rate patterns may be possible
- 4) the data obtained from an overall quantitative measurement of fetal heart rate patterns can be subjected to multivariate statistical techniques
- 5) the Brazelton dimensions of attention-orientation and arousal were significantly predicted from FHR factors in Study III
- 6) although fetal heart rate patterns and birth weight status both correlate with some Brazelton Scale dimensions, they appear to be complimentary predictors accounting for unique sources of variance

Implications of Present Findings for Future Research

One of the most basic implications of this study is the need for developmental life-span research. Huston-Stein and Baltes (1976) have said that the all-inclusive concern of developmental psychology is with systematic long-term behavior change processes. One can think of few places to begin a developmental study of the child that has advantages over the newborn period. A second implication of the present study concerns the use of fetal heart rate data obtained during labor. Although there are over 250 references related to fetal heart rate monitoring since 1970, only a handful are specifically concerned

with neonatal behavior. This may be the first attempt to relate fetal heart rate monitoring data to the Brazelton Neonatal Assessment Scale. Moreover, the system of scoring fetal heart rate patterns may stimulate future research with this approach. Further, the use of fetal heart rate patterns and other physiologic response systems in conjunction with behavioral measures may have strong implications for the newborn's later social development. An understanding of the newborn's social development and effect upon the care-taking environment may be enhanced from knowledge of relationships between autonomic functions and newborn behavior. It may be that the environment which is shaped by the newborn's behavioral responses are directly related to physiologic tolerances for the stress of birth.

APPENDIX

Definition of Fetal Heart Rate Patterns used in Study III

- a) Deceleration are defined as decreases in fetal heart rate ≥ 15 bpm and lasting at least 20 seconds.
- b) Accelerations are defined as increases in fetal heart rate ≥ 15 bpm and lasting at least 20 seconds.
- c) Baseline heart rate is defined as the number of beats per minute between contractions in the absence of accelerations or decelerations. Figure I, which has no heart rate changes with contractions has a baseline rate of 123 bpm.
- d) Baseline variability is the beat-to-beat fluctuations in heart rate. Variability is measured during the interval between contractions when there are no accelerations or decelerations. These fluctuations differ from accelerations and decelerations in that their magnitude is ≤ 15 bpm and duration ≤ 10 seconds.

LIST OF REFERENCES

- Aleksandrowicz, M. The Effect of Pain Relieving Drugs Administered During Labor and Delivery on the Behavior of the Newborn. A Review. Merrill-Palmer Quarterly, 1973.
- Aleksandrowicz, M., Aleksandrowicz, D. Obstetrical pain-relieving drugs as predictors of infant behavior variability. Child Development, 1974, 45.
- Andre-Thomas, Chesni, Y., & Saint-Anne-Dargassies, S. The Neurological Examination of the Infant. London: Medical Advisory Committee of the National Spastics Society, 1960.
- Appleton, T., Clifton, R., Goldberg, S. The Development of Behavioral Competence in Infancy. In Review of Child Development Research, Vol. 4 (Ed). Horowitz, F., 1975, University of Chicago Press.
- Babson, S. G. & Benson, R. C. Management of High-risk Pregnancy and Intensive Care of the Neonate. St. Louis: Mosby, 1971.
- Ballas, S., Toaff, M. E., Toaff, R. Effects of Intravenous Meperidine and Meperidine with Promethazine on Uterine Activity and Fetal Heart Rate During Labor. Israel Journal of Medical Science, 12, 10, 1976.
- Basket, T. F., Koh, K. S. Sinusoidal Fetal Heart Pattern: A Sign of Fetal Hypoxia. Obstetrics and Gynecology, Vol. 44, No. 3, 1974.
- Beard, R. W. The Detection of Fetal Asphyxia in Labor. Pediatrics, Vol. 53, No. 2, 1974.
- Bell, R., Weller, G., & Waldrop, M. Newborn and preschooler: Organization of behavior and relations between periods. Monographs of the Society for Research in Child Development, 1971, Vol. 36.
- Bernard, S. & Sontag, L. W. Fetal reactivity to tonal stimulation: A Preliminary Report. Journal of Genetic Psychology, 1947, 70.
- Birch, H. G. & Gussow, G. D. Disadvantaged Children. New York: Grune & Stratton, 1970.
- Boehm, F., Woodruff, L., Growdon, J. The Effects of Lumbar Epidural Anesthesia on Fetal Heart Rate Baseline Variability. Anesthesia and Analgesia...Current Researches, Vol. 54, 1975.
- Bowes, W. A., Brackbill, Y., Conway, E. & Steinschneider, A. The effects of obstetrical medication on fetus and infants. Monograph of the Society for Research in Child Development, 1970, 35, (4, Serial NO 137).

Brackbill, Y., Kane, J., Maniello, R. L., & Abramson, D. Obstetric pre-medication and infant outcome. American Journal of Obstetrics and Gynecology, 1974, 118.

Brazelton, T. B. Effect of prenatal drugs on the behavior of neonates. American Journal of Psychiatry, 1970, Vol. 126.

Brazelton, T. B. Neonatal Behavioral Assessment Scale. Clinics in Developmental Medicine, No. 50, Philadelphia: Lippincott, 1973.

Brazelton, T. B. & Collier, G. A. Infant Development in the Zinncanteco Indians of Southern Mexico. Pediatrics, 44, 1969.

Brazelton, T. B. & Freedman, D. G. Manual to Accompany Cambridge Newborn Behavioral and Neurological Scales. In Normal and Abnormal Development of Brain and Behavior (Eds.) Stoelting, G.B.A., & Van Der Werff Ten. Leiden University Press, 1971.

Brazelton, T. B., Koslowski, B., Tronick, E. Neonatal Behavior among Urban Zambians and American. American Journal of Child Psychiatry, 1976.

Brown, W., Bell, G., Alper, M. Acidosis, Local Anesthetics and the Newborn. Obstetrics and Gynecology, Vol. 48, 1976.

Caputo, K. & Mandell, W. Consequences of Low Birthweight. Developmental Psychology, 1970, 3.

Chan, H., Paul, R., & Towes, J. Intrapartum Fetal Monitoring. Maternal and Fetal Morbidity and Perinatal Mortality. Obstetrics and Gynecology, Vol. 41, No. 1, 1973.

Chik, L., Sokol, R., Rosen, M. "Prediction" of the One-Minute Apgar Score From Fetal Heart Rate Data. Obstetrics and Gynecology, 48, 1976.

Chronbach, L. J. & Meehl, P. E. Construct Validity in Psychological Test. Psychological Bulletin, 1955, 52.

Cibils, L. Clinical significance of fetal heart rate patterns during labor. II. Late decelerations. American Journal of Obstetrics and Gynecology, 1975.

Cibils, L. Clinical significance of fetal heart rate patterns during labor. I. Baseline patterns. Vol. 125, American Journal of Obstetrics and Gynecology, 1976.

Conway, E. & Brackbill, Y. Delivery medication and infant outcome. An empirical study. Monographs of the Society for Research in Child Development, 1970, Vol. 35.

Cooley, W. W. & Lohnes, P. R. Multivariate data analysis. New York: Wiley, 1971.

Drillien, C. M. The Growth and Development of the Prematurely Born Infant. Baltimore: Williams & Wilkins, 1964.

Emory, E. K., Lester, B. M. & Eitzman, D. V. Brazelton Scale Performance of Infants of Varying Birth. Presented at the Fourth Biennial Meeting of the Southeastern Conference on Human Development, 1976.

Freeman, R. Intrapartum. Fetal Evaluation. Clinical Obstetrics and Gynecology, Vol. 17, 3, 1974.

Freedman, C. & Freedman, N. Behavioral differences between Chinese-American and European-American newborns. Nature, 1969.

Gabert, H. & Stenchever, M. Electronic fetal monitoring in association with paracervical block. American Journal of Obstetric and Gynecology, Vol. 116, No. 8, 1973.

Garmezy, N. Models of Etiology for the study of children at risk for Schizophrenia. In Life History Research in Psychopathology (Eds.) Merrill Roff, Lee Robins, Max Pollack, 1972, Vol. 2, University of Minnesota Press.

Goddard, W. B. Fetal monitoring in a private hospital. Observations of fetal bradycardia following paracervical block anesthesia. American Journal of Obstetrics and Gynecology, Vol. 115, 1971.

Haith, M. M. & Campos, J. J. Human Infancy. Annual Review of Psychology, 1977, Vol. 28.

Hirschman, R. & Katkin, E. Psychophysiological Functioning, Arousal, Attention, and Learning During the First Year of Life. Advances in Child Development and Behavior, Vol. 9, 1974 (Ed.) Reese, H. R.

Hon, E. An Introduction to Fetal Heart Rate Monitoring, 2nd Edition, 1975.

Horowitz, F. K., Self, P. A., Paden, L. Y., Culp, R., Laubk, K., Boyd, E., & Mann, M. E. Newborn and four week retest on a normative population using the Brazelton Newborn Assessment Procedure. Paper presented at the Annual Meeting of the Society for Research in Child Development, 1971.

Huston-Stein, A. H. & Baltes, P. B. Theory and Method in Life-Span Developmental Psychology: Implications for Child Development. Advances in Child Development and Behavior. Vol. 11, 1976, (Ed.) Reese, R.

Isaacson, R. L. The Limbic System. 1974. Plenum Press, New York.

James, L. S., Morishima, H., Daniel, S., Bowe, E., Cohen, H., Niemann, W. Mechanism of Late Deceleration of the Fetal Heart Rate. American Journal of Obstetrics and Gynecology, Vol. 113, 1972.

Kaiser, H. F. The Application of Computers to Factor Analysis. Educational and Psychological Measurement, 1960, 20.

Kaiser, H. F. Psychometric Approaches to Factor Analysis. In Proceedings of the 1964 Invitational Conference on Testing Problems. Princeton, N.J.: Educational Testing Service, 1965.

Kessen, W. Sucking and Looking. Two Organized Congenital Patterns of Behavior in the Human Newborn. In H. Stevenson, E. Hess, & H. Rheingold (Eds.) Early Behavior, New York: Wiley, 1967.

Korner, A. F. Individual Differences at Birth; Implications for Early Experience and Later Development. American Journal of Orthopsychiatry, 41, 4, 1971.

Lee, C. Y., Di Loreto, P. C., & O'Lane, J. M. A Study of Fetal Heart Rate Acceleration Patterns. Obstetrics and Gynecology, 45, 1975.

Lester, B. M., Emory, E. K., Hoffmen, S., & Eitzman, D. V. A Multivariate Study of the Effects of High-Risk Factors on Performance on the Brazelton Neonatal Assessment Scale, Child Development, 1976, 47.

Lilienfeld, A. M. & Parkhurst, E. A Study of Association of Factors of Pregnancy and Parturition with the Development of Cerebral Palsy: A Preliminary Report. American Journal of Hygiene, 1951, 53.

Lipton, E. L., Steinschneider, A., & Richmond, J. B. The Autonomic Nervous System in Early Life. New England Journal of Medicine, 1965.

Low, J. A., Pancham, S. R., & Worthington, D. N. Intrapartum Fetal Heart Rate Profiles With and Without Fetal Asphyxia. Journal of Obstetrics and Gynecology, 1977.

Low, J. A., Pancham, S. R., Worthington, D. N. Fetal Heart Deceleration Patterns in Relation to Asphyxia and Weight-Gestational Age Percentile of the Fetus. Obstetrics and Gynecology, 47, 1976.

Lubchenco, L. O. The High-Risk Infant. W. B. Saunders, Philadelphia, 1976.

Luria, A. R. The Working Brain. An Introduction to Neuropsychology. Basic Books, Inc., New York, 1973.

Martin, C., Siassi, B., Hon, E. Fetal Heart Rate Patterns and Neonatal Death in Low Birthweight Infants. Obstetrics and Gynecology, Vol. 44, 1974.

McDevitt, D. G., Wallace, R. J., & Roberts, A. The Uterine and Cardiovascular Effects of Salbutamol and Practolol During Labor. British Journal of Obstetrics and Gynecology. Vol. 82, 1975.

Mendez-Bauer, C., Arnt, I. C., Gulin, L., Escarcena, L., & Caldeyro-Barcia, R. Relationship Between Blood pH and Heart Rate in the Human Fetus During Labor. American Journal of Obstetrics and Gynecology, 97, 1967.

Moreau, T. & Birch, H. Relationship Between Obstetrical General Anesthesia and Rate of Neonatal Habituation to Repeated Stimulation. Developmental Medicine and Child Neurology, 1974, 10.

Nash, J. Developmental Psychology: A Psychobiological Approach. Prentice-Hall, Inc. Englewood Cliffs, 1970.

National Center for Health Statistics. Infant and Perinatal Mortality in the United States. Vital and Health Statistics. PHS. Pub. No. 1000, Series 3 and 4. Public Health Service. Washington, D.C. U.S. Government Printing Office, 1965.

Nie, N., Bent, D. H., & Hull, C. Statistical Packages for the Social Sciences. New York: McGraw-Hill, 1970.

Pasamanick, B. & Knobloch, H. Epidemiologic Studies on the Complications of Pregnancy and the Birth Process. In G. Caplan (Ed.) Prevention of Mental Disorders in Children. New York: Basic Books, 1961.

Paul, R. & Hon, E. Clinical Fetal Monitoring. A Survey of Current Usage. Obstetrics and Gynecology, 37, 1971.

Paul, R. & Hon, E. A Clinical Fetal Monitor. Obstetrics and Gynecology, 35, 1970.

Pratt, K. C. The Neonate. In L. Carmichael (Ed.) Manual of Child Psychology, 2nd Ed. New York: John Wiley, 1954.

Prectal, H. & Beintema, D. The Neurological Examination of the Full Term Newborn Infant. Clinics in Development Medicine, 1964, No. 12, London: Spastic Society.

Quilligan, E. J. & Paul, R. H. Fetal Monitoring: Is It Worth It? Obstetrics and Gynecology, 45, 1975.

Rochard, F., Schiffrin, B., Goupil, F., Legrand, H., Blottiere, C., & Sureau, C. Nonstressed Fetal Heart Rate Monitoring in the Antepartum Period. American Journal of Obstetrics and Gynecology, 1976.

Saldana, L., Schulman, H., Yang, W. Electronic Fetal Monitoring During Labor. Obstetrics and Gynecology, Vol. 14, No. 6, 1976.

Saling, E. & Schneider, D. Biochemical Supervision of the Fetus During Labor. Journal of Obstetrics and Gynecology. British Commonwealth, 74, 1967.

Sameroff, M. & Chandler, M. Reproductive Risk and the Continuum of Caretaking Casualty. In Review of Child Development Research, Vol. 4, (Ed.) Horowitz, F., 1975, University of Chicago Press, Chicago.

Scarr, S. & Williams, M. The Assessment of Neonatal and Later Status in Low Birthweight Infants. Paper presented at meeting of the Society for Research in Child Development, April, 1971.

Schifferli, P. Y. & Caldeyro-Barcia, R. Effects of Atropine and Beta-adrenergic Drugs on the Heart Rate of the Human Fetus, in Boreus, I., (Ed.): Fetal Pharmacology, New York, 1973, Raven Press.

Schiffrin, B., & Dame, L. Fetal Heart Rate Patterns: Prediction of Apgar Score. Journal of American Medical Association, 219, 1972.

Self, P. Assessment of Infants Under One Month of Age. Unpublished manuscript. Department of Human Development University of Kansas, 1971.

Shenker, L. Clinical Experiences with Fetal Heart Rate Monitoring of One Thousand Patients in Labor. American Journal of Obstetrics and Gynecology, Vol. 115, No. 8, 1973.

Soule, A., Standley, D., Copans, S., & Davis, M. Clinical uses of the Brazelton Neonatal Scale. Pediatrics, 54, 1974.

Stechler, G. Newborn Attention as Affected by Medication During Labor. Science, 1964, 144.

Steinschneider, A. Developmental Psychophysiology. In Y. Brackbill (Ed.) Infancy and Early Childhood: Free Press, 1967.

Standley, D., Soule, A., Copans, S., & Duchowney. Local-regional Anesthesia During Childbirth: Effects on Newborn Behavior. Science, 1974, 186.

Strauss, M. E., Lessen-Firestone, J., Starr, R., & Ostrea, E. M. Behavior of Narcotic-addicted Newborns. Child Development, 46, 1975.

Tejani, N., Mann, L., & Bhakthavathsalan, A. Correlation of Fetal Heart Rate Patterns and Fetal pH with Neonatal Outcome. Obstetrics and Gynecology, 48, 1976.

Thomas, A., Chess, S., & Birch, H. G. Temperament and Behavior Disorders in Children. New York: New York University Press, 1968.

Timor-Tritsch, I., Gergely, Z., Abramovici, H., & Brandes, J. M. Electronic monitoring of the fetal heart rate and uterine contractions during Cesarean section under balanced anesthesia. Obstetrics and Gynecology, Vol. 48, 3, 1976.

Tronick, E. & Brazelton, T. B. Clinical uses of the Brazelton Scale. In Friedlander, Sterrit & Kirk. Exceptional Infant, Vol. 3, 1975.

Uzgiris, I. Patterns of Cognitive Development in Infancy. Merrill-Palmer Quarterly, Vol. 19, 3, 1973.

Vasicka, A., Robertazzi, R., Raji, M., Scheffs, J., Kosmowski, J., & Goei, J. Fetal Bradycardia After Paracervical Block. Obstetrics and Gynecology, Vol. 38, 4, 1971.

Vaughan & McKay. Textbook of Pediatrics, Philadelphia: W. B. Saunders, 1975.

Weiner, G., Bider, R. V., Oppel, W. C., & Harper, P. A. Correlates of Low Birthweight. Psychological Status at Eight to Ten Years of Age. Pediatric Research, 1968, 2.

Yang, R., Zweig, A., Douthitt, T., & Federman, E. Successive Relationships Between Maternal Attitudes During Pregnancy, Analgesic Medication During Labor and Delivery, and Newborn Behavior. Developmental Psychology, Vol. 12, 1976.

Zootzmann, B. G. The History of Monitoring the Human Fetus. Journal of Perinatal Medicine, 3, 1975.

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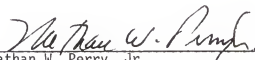
He is a member of the Society for Research in Child Development.

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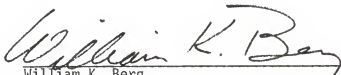
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